DEPARTMENT OF GERIATRICS
CHRISTIAN MEDICAL COLLEGE, VELLORE

NUTRITIONAL STATUS OF ELDERLY PRESENTING TO GERIATRICS OUT – PATIENT CLINIC USING MINI NUTRITIONAL ASSESSMENT AND CORRELATION WITH FRAILTY

A dissertation submitted in partial fulfilment of M.D. Geriatrics Branch XVI Examination of the Tamil Nadu Dr M.G.R. UNIVERSITY, CHENNAI to be held in 2017

CERTIFICATE

This is to certify that the dissertation "**Nutritional status of elderly presenting to Geriatrics out – patient clinic using mini nutritional assessment and correlation with frailty**" is the bonafide work of **Dr. Niranjana Sreedevi N** carried out under our guidance towards the M.D. Branch XVI (Geriatrics) Examination of the Tamil Nadu DR M.G.R. University, Chennai to be held in 2017.

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DECLARATION CERTIFICATE

This is to declare that the dissertation titled "**Nutritional status of elderly presenting to Geriatrics out – patient clinic using mini nutritional assessment and correlation with frailty**" is the bonafide original work done by me in partial fulfilment towards M.D. Branch XVI (Geriatrics) Degree Examination of the Tamil Nadu Dr. M.G.R. University, Chennai to be held in 2017 and due acknowledgement has been made in the text to all the materials used.

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I am thankful towards Ms Hepsy for helping me in data analysis

and Ms Melanshya Pears for helping me in data collection

I am also thankful to all patients who participated in the study.

IRB ACCEPTANCE CERTIFICATE

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July 06, 2016

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Nutritional Status Of Elderly Presenting To Geriatrics Out-Patient Clinic Using Mini Nutritional Assessment And Correlation With Frailty.
DR Niranjana Sreedevi N, Employment Number: 33449, PG Registrar, Geriatric Medicine. Dr Prasad Mathews K, Emp. No. 12381, Professor, Dr Gopinath K G, Emp. No. 28453, Associate Professor, Department of Geriatric Medicine. Dr Visalakshi Jeyaseelan, 31093, Biostatistics.

Ref: IRB Min No: 10026 [OBSERVE] dated 04.04.2016

Dear DR Niranjana Sreedevi,

I enclose the following documents:-

1. Institutional Review Board approval 2. Agreement

Could you please sign the agreement and send it to Dr. Biju George, Addl. Vice Principal (Research), so that the grant money can be released.

With best wishes,

Dr. Biju George
Secretary (Ethics Committee)
Institutional Review Board

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Dear DR Niranjana Sreedevi,

The Institutional Review Board (Blue, Research and Ethics Committee) of the Christian Medical College, Vellore, reviewed and discussed your project titled "Nutritional Status Of Elderly Presenting To Geriatrics Out-Patient Clinic Using Mini Nutritional Assessment And Correlation With Frailty" on April 04 2016.

The Committee reviewed the following documents:

1. IRB Application format
2. Informed consent sheet in three languages. (English, Tamil, Hindi)
3. Patient Information sheet (English, Tamil, Hindi)
4. Cvs of Drs. Gopinath, Prasad, Niranjana.
5. Proforma
6. No.of documents 1 - 5

The following Institutional Review Board (Blue, Research & Ethics Committee) members were present at the meeting held on April 04th 2016 in the CREST/SACN Conference Room, Christian Medical College, Bagayam, Vellore - 632002.

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Dr. Ratna Prabha	MBBS, MD (Pharma)	Associate Professor, Clinical Pharmacology, CMC, Vellore	Internal, Pharmacologist

We approve the project to be conducted as presented.

Kindly provide the total number of patients enrolled in your study and the total number of with drawals for the study entitled: "Nutritional Status Of Elderly Presenting To Geriatrics Out-Patient Clinic Using Mini Nutritional Assessment And Correlation With Frailty" on a monthly basis. Please send copies of this to the Research Office (research@cmcvellore.ac.in).

Fluid Grant Allocation:

A sum of 5,000/- INR (Rupees Five Thousand Only) will be granted for 3 Months.

Yours sincerely

Dr. Biju George
Secretary (Ethics Committee)
Institutional Review Board

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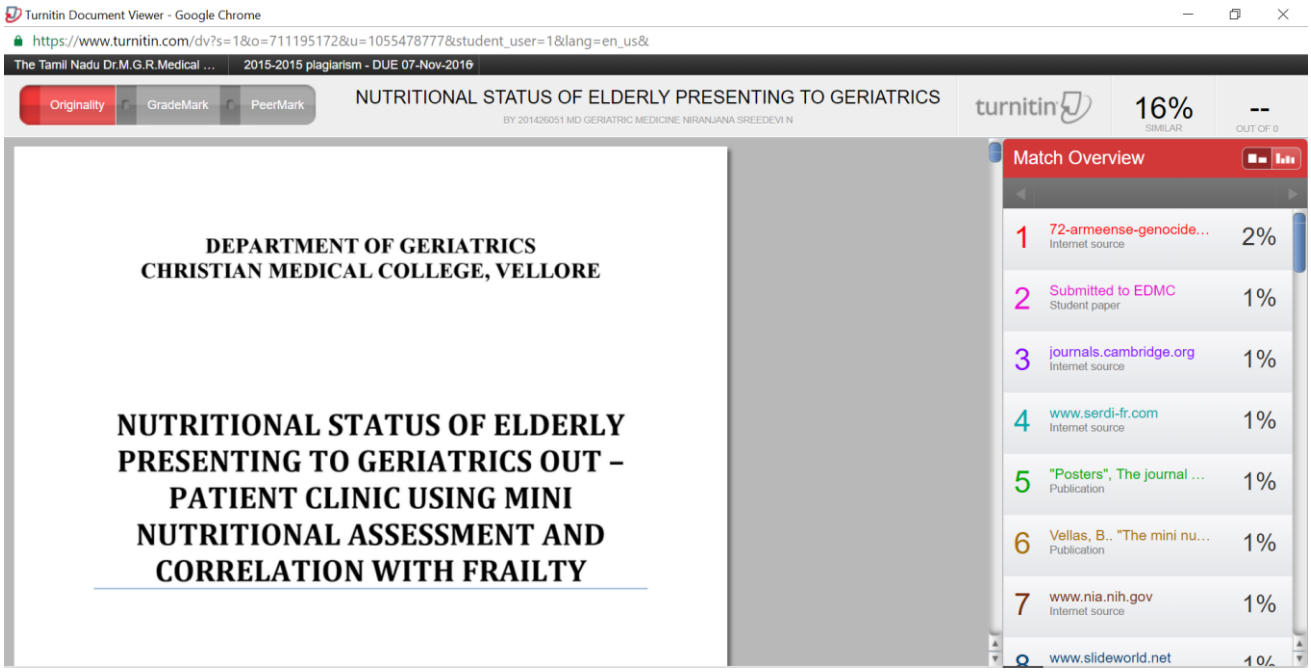

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1 INTRODUCTION

As the world enters a demographic transition into senescence, the proportion of elderly who constituted nearly 8% of the world population in 2010 is expected to double to 16% by 2050. Geriatric care is assuming paramount importance. The problems of the elderly are many, contributing to their morbidity and mortality. One problem generally overlooked by the health care team is the nutritional status of the elderly.

Nutritional problems are diverse ranging from malnutrition to over nutrition. With global nutritional transition where people seek unhealthy fast food, obesity is taking over the stage of nutritional problems from malnutrition. But malnutrition is also an equally important problem especially in developing countries and particularly among the elderly.

With increase in life expectancy there is a steady rise in the elderly population. Global life expectancy has increased by 5 years from 2000 to 2015; the current expectancy being 71.4 years globally and 68.45 years in India. Advances in geriatric care have to keep up with this expansion, ranging from simple interventions like nutritional modification to major surgeries

The concept of frailty is very important in this scenario. Frailty which is the core of geriatric medicine is an important predictor of morbidity and mortality.

In this study we look at a group of elderly and assess their nutritional status and frailty.

2 AIMS

To assess the prevalence of malnutrition and frailty in elderly patients who are attending the Geriatrics OPD and to study the correlation between nutritional status and frailty

3 OBJECTIVES

Primary: To study the correlation between nutritional status and frailty in the elderly presenting to the Geriatrics OPD in a tertiary care center in south India

Secondary: To study correlations between individual components of frailty assessment and the nutritional status of the elderly.

4 REVIEW OF LITERATURE

4.1 INTRODUCTION

4.1.1 ELDERLY POPULATION

The definition of old age varies in different areas. The Government of India has brought forth the 'National Policy on Older Persons' which was adopted in January, 1999. As per that, 'senior citizen' or 'elderly' is defined as a person who is of age 60 years or older(1). With increasing life expectancy due to medical advances,

the number of elderly is expected to double by 2050( ). This will require radical societal change, as per the WHO report on the International Day of Older Persons.

The increasing life expectancy together with falling fertility rates will cause population aging to continue, even accelerate. The number of people aged 65 or older is expected to grow from an estimated 524 million in 2010 to nearly 1.5 billion in 2050, with most of the increase in developing countries.(2)

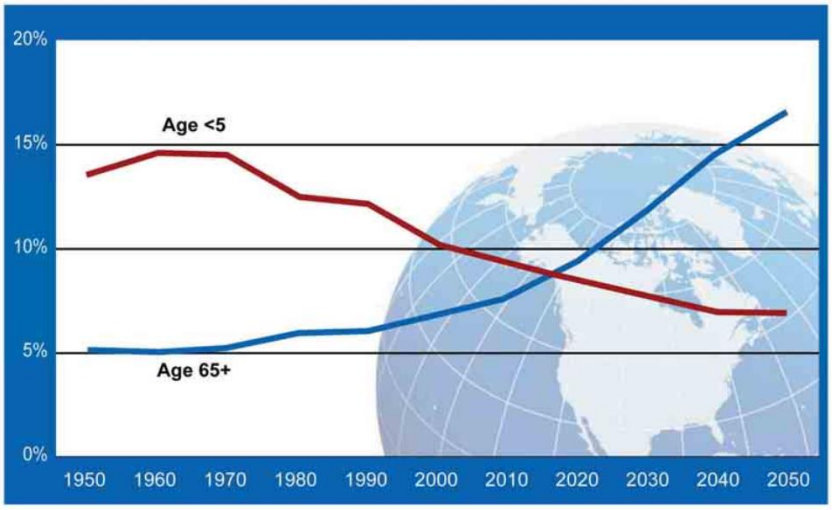
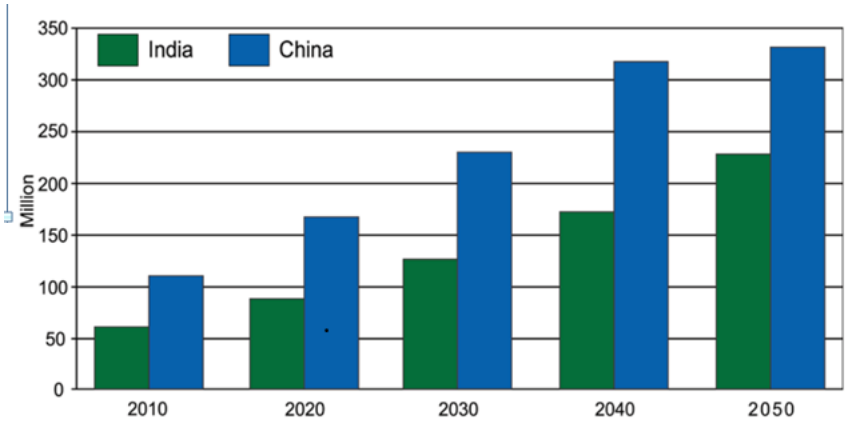


Figure 1 Young Children and Older People as a Percentage of Global Population: 1950-2050

Source: United Nations. *World Population Prospects: The 2010 Revision.*
Available at: http://esa.un.org/unpd/wpp.

This rise in the elderly population can challenge national infrastructures, and health systems in some countries. This surge in numbers of older people is dramatically illustrated in China and India; the world's two most populous countries (Figure 2). China will witness a surge in the geriatric population to 330 million by 2050 from 110 million today. India's current older population of 60 million is projected to increase by nearly 280 percent, exceeding 227 million in 2050. (2)



Source: United Nations. *World Population Prospects: The 2010 Revision.*
Available at: http://esa.un.org/unpd/wpp.

Figure 2 Growth of the Population Aged 65 and Older in India and China 2010-2050

4.1.2 INDIA – STATISTICS

The 2011 Population Census estimated that there were about 104 million elderly in India of which 51 million were males and 53 million, females Figure 3. The Population Census of 1991 showed a higher number of elderly males than females. But this trend showed a steady reversal over the past two decades. This is a cause for concern for policy makers as elderly women are much more vulnerable than men on all fronts. 73 million elderly who account to 71% of their total population reside in rural India. (1)

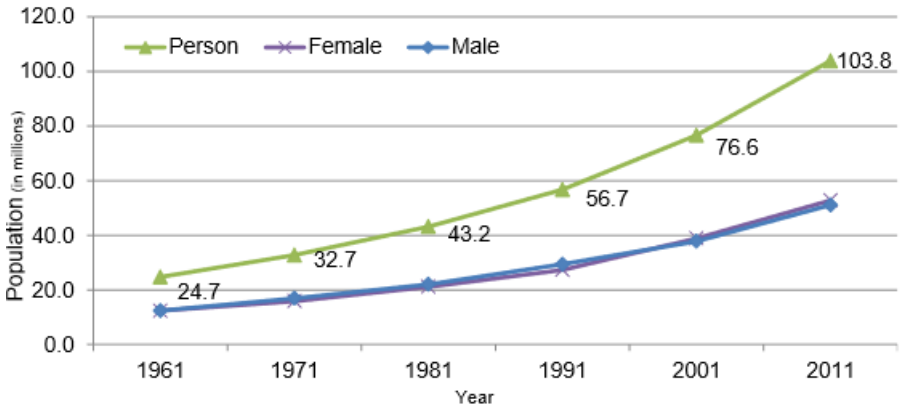


Figure 3 Elderly population (aged 60 years & above) from population Census Data

4.1.3 CO-MORBIDITIES IN THE ELDERLY

As the demography of the elderly changes, the epidemiology of comorbidities has also transformed. Non-communicable or chronic diseases such as cancer, diabetes, hypertension, stroke, cardiovascular diseases and geriatric giants like Alzheimer's and other types of dementias have overtaken infectious diseases as being the cause of mortality (Figure 4). Around four-fifth of deaths are due to non-communicable disease in developing countries (3)

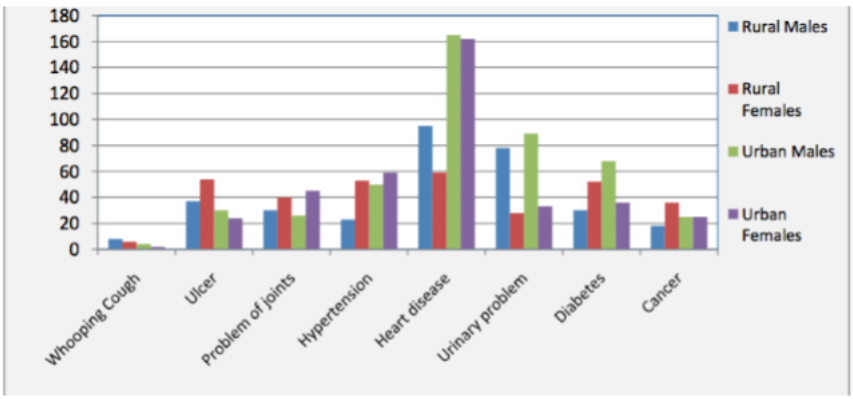


Figure 4 Comorbidities in Elderly

4.2 NUTRIENT REQUIREMENTS IN THE ELDERLY

ENERGY

There is a decline in the daily energy requirements per kilogram of body weight with age. It can decrease by almost 33% between 30 to 90 years. This decline is more in men and people with chronic diseases. Loss of lean muscle mass is the primary reason for this decline as muscle is more metabolically active than fat. The ratio of fat to lean mass increases which in turn causes a drop in basal metabolic rate(BMR). There is also minimal decline in metabolic rate per kilogram of fat-free mass.

This may be due to the age-related change in the ratio of high metabolic rate tissues like muscle to low rate tissues like bone. The BMR amounts to 60% to 75% of the Total Energy Expenditure (TEE) and hence muscle loss leads to significant decline in TEE and hence in energy requirements. Every 10-kg loss of skeletal tissue mass results is calculated to cause an approximate decline of 150 kcal/d in basal energy expenditure. Decreased physical activity with age also leads to reduced energy requirements. (4,5)

Daily energy requirements (kcal/d) are maintenance 25–30 kcal/kg, stress 30–40 kcal/kg and sepsis 40–50 kcal/kg

The decline in energy requirements reduces the nutritional requirement to maintain their weight and activity level. This reduction in dietary intake can lead to protein and micronutrient deficiencies. Hence the elderly need to increase their

activity level and consume more protein and micronutrient rich foods in order to maintain their muscle mass and avoid obesity.

PROTEIN

Studies are lacking in estimating the protein requirement with increasing age. The recommended protein requirements for healthy adults are 0.6 to 0.8 g per kg of body weight per day. Some data suggests that elderly require 1.0 to 1.25 g/ kg/d of proteins.(6)

Daily protein requirements (g/d): RDA healthy adult age 51 + yrs. 0.8 g/kg ;

Minimally stressed patients 1.0 g/kg; Injury/illness 1.2–1.4 g/kg;

Severe stress/sepsis 1.4–1.8 g/kg

FAT AND CHOLESTEROL

Fat is essential as a source of energy and also for the absorption of fat-soluble vitamins. Daily fat intake should account for 10% of total energy requirements for adequate absorption of fat-soluble vitamins (A, D, E, K). This is also imperative to meet the requirements for the essential fatty acids. The two main types of essential fatty acids are the omega-6 series, derived from linoleic acid and the omega-3series, derived from alpha-linolenic acid. These essential fatty acids are imperative for the synthesis of cell membrane phospholipids and eicosanoids. The optimal fat intake in the elderly has to be tailored individually. The beneficial effects of regulating total cholesterol levels to protect from coronary artery disease is much debated.(4)

The National Cholesterol Education Program (NCEP) recommendation:

- Total fat intake to 30% or less of total dietary energy
- Saturated fatty acids 8% to 10%
- Polyunsaturated fatty acids up to 10%
- Mono unsaturated fatty acids up to 15% of total energy intake.

Cholesterol intake should not exceed 300 mg/day. Modifying the dietary fat in response to serum lipids is beneficial.

These guidelines are not applicable to:

- Frail older individuals, especially those who are losing weight involuntarily
- Body mass index less than 20
- Those having disease conditions limiting their nutrient intake.

High fat diet may be necessary for such frail older individuals.

CARBOHYDRATES

Carbohydrates usually account for 55% to 70% of the total dietary intake. On exclusion of carbohydrates, energy requirements are met by the incomplete oxidation of fatty acids, which leads to ketosis which can lead to lethargy and depression. So at least 50 to 100 g of carbohydrates is required each day. Ideal sources of carbohydrates are fiber rich sources which supply complex carbohydrates.(25, 26)

FIBER

Dietary fiber is sourced from components of plant cell walls and include plant polysaccharides and lignin. They are resistant to intestinal enzymatic

digestion. Daily dietary recommendation is about 20 to 35g of fiber a day or10 to13g dietary fiber per1000 kcal consumed. This also has other benefits including a decreased rate of certain forms of cancer, diabetes, heart disease, and obesity. Dietary fiber can be broadly classified into water-insoluble fibers (cellulose, hemicellulose, and lignin) and water-soluble fibers (gum and pectin);each with their own benefits. Both types lower the energy density of the meal. They add to bulk which in turn causes a short-term satiety effect. This prevents overconsumption. Water-insoluble fiber also helps by holding water within the intestinal contents. This leads to an increase in fecal bulk, a reduced gut transit time, and a lower intraluminal pressure within the large bowel.

VITAMINS AND MINERALS

Many older adults are at risk for micronutrient deficiencies. Even healthy adults do not consistently consume recommended amounts of diet rich in vitamins and minerals. The commonest deficient micronutrients include vitamins C, D, E, B-12, thiamine, and folic acid, and the minerals calcium, magnesium, and zinc. So general vitamin and mineral supplementation is recommended even for a healthy older adult.(9)

WATER

Fluid requirements do not change much with age in adults. But elderly above 65 years of age have a reduced ability to regulate their fluid intake and hence are

more at risk for dehydration when their health status or environment changes. There is a decline in the intensity of the thirst response to fluid deprivation with age. There is a delay in correcting the subsequent rise in serum osmolarity. Also kidneys have lesser ability to concentrate the urine despite an increase in serum vasopressin concentration.

Chronic diseases and injuries can cause dehydration by altering perception of thirst and decreasing access to hydration. Life-threatening dehydration can develop rapidly when an older adult develops an acute febrile illness. Maintenance water requirements range from 1500 to 2500 mL/d or approximately 30 mL/kg body weight/day. This is about 1mL/kcal of food intake/day. Requirements increase with fever, activity, or warm climate. Close monitoring of fluid intake is needed in vulnerable individuals. Hydration status can be further assessed by body weight, orthostatic blood pressure and serum electrolytes, urea nitrogen, and creatinine. Urine output monitoring is practical only in an in-patient situation. Skin turgor is not a reliable indicator of hydration status in the elderly.(5)

4.3 FACTORS INFLUENCING NUTRITIONAL STATUS IN THE OLDER ADULT

4.3.1 CHANGES IN BODY COMPOSITION

With age, significant changes occur in the body composition which affects the individual's nutritional needs. Cross-sectional studies have shown that in most people there is a steady increase in weight from age 30 to 60 years. A majority of

this is attributed to an increase in total body fat. Weight usually stabilizes beyond 60 years after which, there is a decline (Figure 5). It is more difficult to maintain the weight in the later years of life. There is significant weight loss past the seventh decade. There is a progressive reduction in the lean body mass with age. This is associated with a rise in total body fat and also fat redistribution from periphery to the centre. Cross-sectional studies have shown that these changes begin after the age of 30 years and that there is a rapid increase after the age of 65. The higher prevalence of chronic diseases at this age also contributes to this. There is a loss, predominantly, of the skeletal muscle, especially the type II or fast twitch fibers which account for most of the lost lean body mass. Figure 6 shows cross-sectional CT images of the mid thighs of a younger and an older woman showing the relative increase in fat mass and decline in muscle mass with age.

The central lean body mass which include liver and other splanchnic organs are relatively preserved.(10,11). There is also an increase in the relative amount and the distribution of body fat. From the twenties to the nineties , the contribution of fat to the body weight increases by 35% to 50% in females (Figure 5) ; this can be higher in males(12)

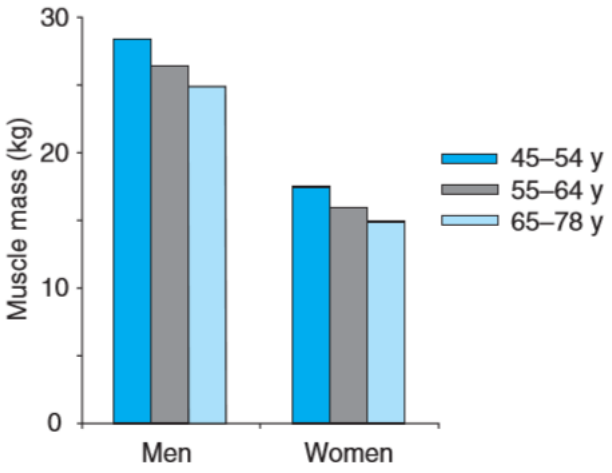


Figure 5 Muscle mass decline with age. (13)

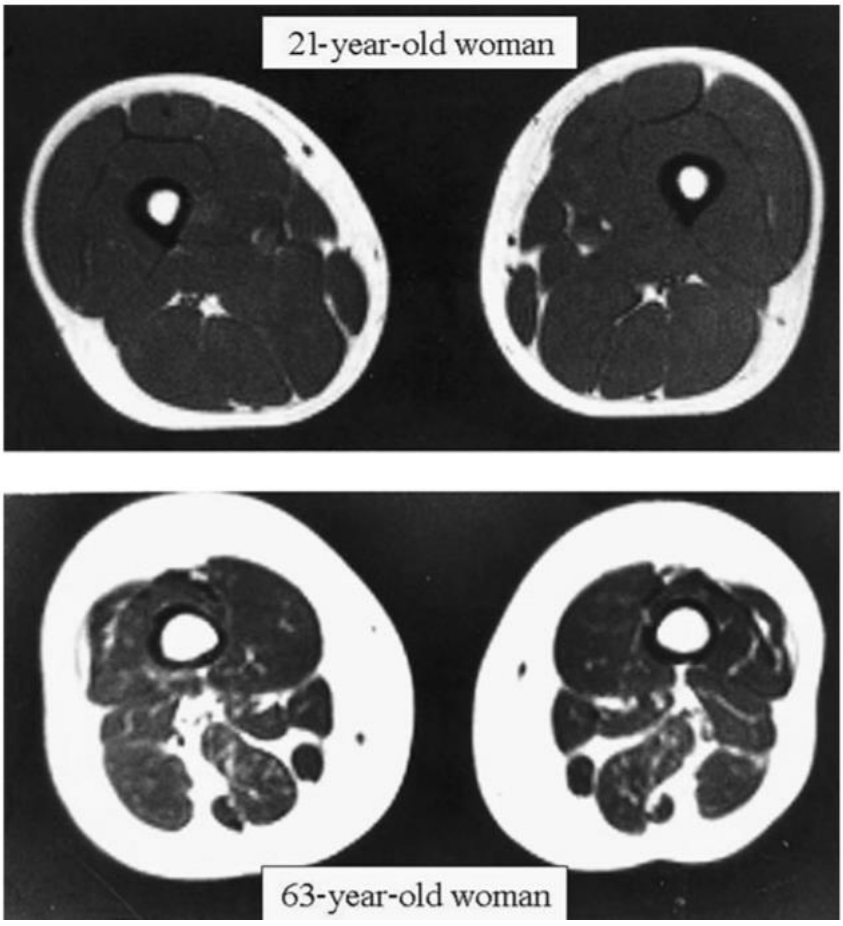


Figure 6 Cross-sectional CT images of the mid thighs of a younger and an older woman

4.3.2 SARCOPENIA

The major age-related physiological change in older people is a decline in skeletal muscle mass, known as sarcopenia(14). A lot of factors contribute to this. These include changes in the metabolism, function and structure of organs. Diseases and their treatment also cause major effects as do an individual's behaviour and lifestyle. There is an ongoing loss of alpha motor units in the spinal column. There is also a decrease in the capacity to synthesize intrinsic muscle protein and a decline in the production of several hormones like oestrogen, testosterone, and insulin-like growth factors. Reduction in nutritional intake and reduced levels of activity with age also are potential contributors to muscle mass loss . With age there is a loss of exercise capacity which has a vice versa relationship with muscle mass. There is a downward spiral triggered by this reduced exercise capacity which will eventually affect the activities of daily living. This would indirectly lead to coronary artery disease, diabetes mellitus, and other diseases that would accelerate the decline.

Table 1 Sarcopenia – Primary causes (due to ageing)

1. Genetic, low birth weight, growth failure
2. Sedentary lifestyle, lack of exercise
3. Immobility or inactivity, due to disability
4. Reduced levels or reduced responsiveness to trophic hormones
    a. Insulin like growth factor 1
    b. Growth hormone and Androgens (testosterone)
    c. Estrogens (estrone, estradiol) dehydroepiandrosterone sulfate 25-hydroxy ergocalciferol (vitamin D)
5. Nutritional
    a. Under nutrition or specific nutrient deficiencies

b. Decrease or imbalance in protein metabolism
c. Decrease in basal metabolic rate

6. Neuromuscular
    a. Neurodegenerative disorders
    b. Muscle fiber atrophy
    c. Apoptosis
7. Disease or trauma
    a. Damage from cytokine expression

Weight cycling is a situation where, when an older person loses weight during an acute illness, it is predominantly loss of lean muscle mass. When the same person regains all or even part of it later, this is in the form of fat.

4.3.3 AGE RELATED CHANGES IN THE DIGESTIVE SYSTEM

Digestive functions are adversely affected by several changes in organ function during advancing age. Aging causes significant effects on oropharyngeal and upper oesophageal motility, GI immunity, colonic function, and GI drug metabolism. But several essential functions like intestinal secretion may be preserved because the GI tract exhibits significant reserve capacity.(15) Figure 7

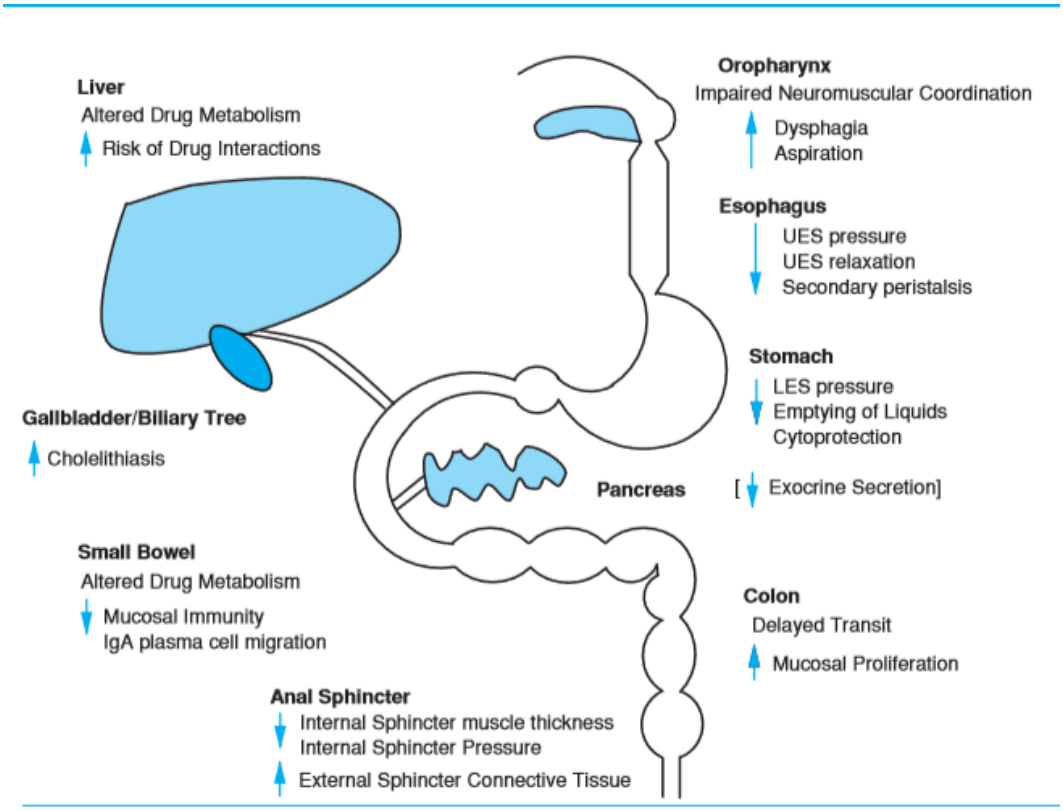


Figure 7 Effects of aging on the gastrointestinal tract. **(16)**

4.3.4 ANOREXIA OF AGING

The term “anorexia of aging” is a term used to refer to the physiologic reduction in appetite and food intake that accompanies normal aging(17) . It is a true geriatric syndrome because it is a multifactorial condition associated with multiple negative health outcomes

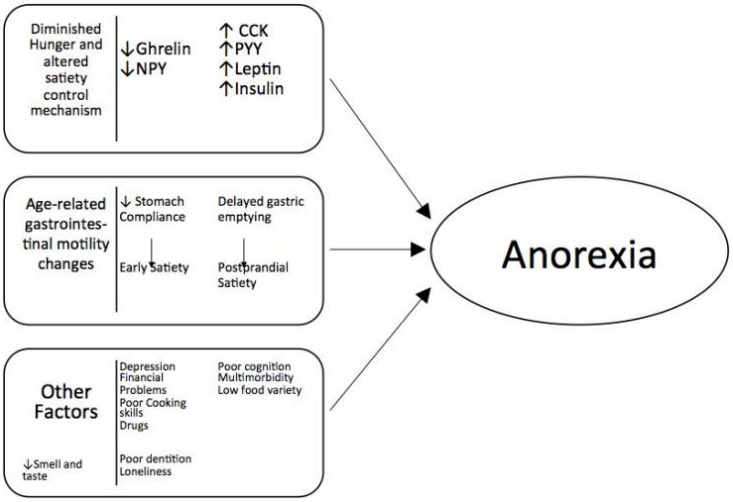


Figure 8 Mechanisms of anorexia of aging

Smell and Taste

The sense of smell and the number of taste buds decrease with age. There is loss of salty and sweet tastes first. This makes the diet less varied. Other factors like diseases and medications can also affect this.

Hormones

Ghrelin, or the "hunger hormone", released by ghrelin cells in the stomach mucosa, is the only peripheral hormone identified to stimulate hunger. There is an increase in *leptin* and *insulin* levels, both of which are satiety hormones. It is believed that increase in leptin and insulin will also cause lower sensitivity to ghrelin in older adults(18). *Cholecystokinin* (CCK) is the prototype of satiety hormones, released by the proximal small intestine and modified CCK dynamics is postulated to be a cause of anorexia of aging(18). A raised serum *peptide YY* (PYY) level in the late postprandial phase is also thought to induce satiety. *Glucagon-like*

peptide 1 (GLP-1) is released by the lining of the intestine in response to nutrient ingestion and it slows gastric emptying. GLP-1 stimulates insulin secretion and, together with gastric inhibitory peptide, is one of the incretin hormones(19).

Gastric Function

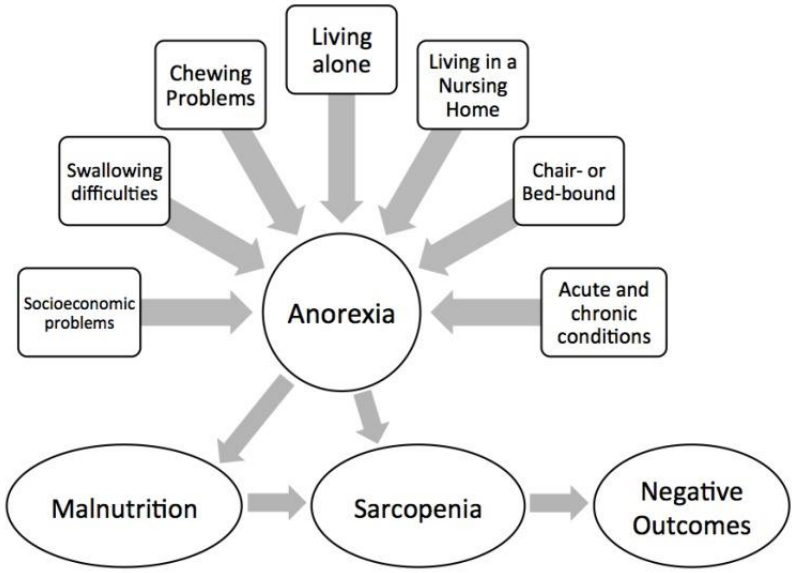
There is decreased secretion of nitric oxide in the fundus of the stomach which causes loss of gastric compliance and rapid antral filling. This, along with decreased gastric motility resulting in delayed gastric emptying, causes a decrease in appetite and food intake. Several drugs like proton-pump inhibitors also worsen this by causing hypochlorhydria.

Inflammation

Chronic low-grade inflammation which is a hallmark of aging may modify the response of target brain areas to peripheral stimuli. Elderly have higher levels of circulating interleukin 1 (IL1), IL6 and tumor necrosis factor alpha (TNF- α) which is independent of specific diseases(20). This in turn stimulates leptin mRNA expression thereby leading to delayed gastric emptying and decreased small bowel motility causing anorexia(21). They also stimulate hypothalamic corticotropin releasing factor (CRF) which is a mediator of the anorexogenic effect of leptin(21).

Risk factors of anorexia of aging

Figure 9 Risk factors of anorexia of aging



4.4 MALNUTRITION IN THE ELDERLY

Malnutrition which is a significant problem in elderly is defined as the state of being poorly nourished. This may be undernutrition (lack of one or more nutrients), or over nutrition (excess of nutrients). Many changes associated with the ageing process can cause malnutrition but it is not an inevitable part of ageing

4.4.1 EPIDEMIOLOGY OF MALNUTRITION

GLOBAL EPIDEMIOLOGY

The prevalence of malnutrition varies depending on the clinical setting. The prevalence obtained from the retrospective pooled analysis of data from studies of

MNA in elderly is as follows. Twenty four data sets from 12 countries were analysed. This included data from nursing home, hospital, rehabilitation centres and community. The prevalence of malnutrition was 22.8%, and there were considerable differences between the settings. The rehabilitation centres had highest prevalence with 50.5%, followed by hospital (38.7%), nursing home (13.8%) and community (5.8%). The prevalence of individuals at risk for malnutrition was 46.2%. On combining the results, approximately two-thirds of study population were at nutritional risk or malnourished. The MNA showed a high prevalence of malnutrition in different settings, except for community.(22)

WHO data shows that malnutrition affects about one-third of the total population particularly in the low-income regions of the world. This varies much across countries. In Taiwan, the prevalence of malnutrition among people aged 60 to 70 years and >80 years is 2 % and 5 % respectively. But in rural Malaysia, 38 % of the elderly are malnourished when using a cut-off of, 18.5 kg/m^2 of BMI as the definition of undernutrition (23,24)

INDIAN EPIDEMIOLOGY

Studies conducted from India showed the following data – A cross sectional study from Punjab showed a malnutrition prevalence of 19.4% of the elderly with chronic energy deficiency.(25) In a population study of sample size 420 conducted in rural south India 93.3 % had caloric intake less than RDA(26) . A cross sectional study conducted in West Bengal using MNA showed a prevalence of 29.4% in the malnourished group and 60 % in the at risk group.(27). In a community study of

227 elderly population in rural south India around 14% were malnourished and 49% were at risk of malnourishment(28)

Table 2 Studies showing Prevalence of Malnutrition determined by the MNA

Author	Type of study	Results
Bauer JM(29)	Cross-sectional study, N=121 Mean age=80 Geriatric hospital	MNA identified 70%with malnutrition or at risk No correlation between MNA and basal ghrelin level was found
Charlton KE(30)	Cross-sectional study, N=283 Mean age=72 Institutionalized (15%); community-dwelling (85%)	Mean MNA=23.5% were malnourished; 50.4% were at risk of malnutrition; 44.4% were well-nourished The MNA was positively and significantly associated with anthropometric values, cognitive function MNA-SF vs full MNA: Sensitivity=100%; Specificity=94.6% MNA-SF was strongly correlated with the full MNA (r=0.811; p<0,0001) MNA-SF was associated with cognitive function score (r=−0.31; p<0,0001)
Feldblum I(31)	Observational study, N=259 Age≥65 Internal medicine departments	Mean MNA score=19.5 18.5% were malnourished; 81.5% were at risk of malnutrition The patients who were malnourished were less educated, had higher depression,

		lower cognitive and physical functioning, had higher chewing problems, higher nausea and vomiting
Gil-Montoya JA(32)	Cross-sectional study, N=2860 Mean age=74 Representative sample of Spaniards	Mean MNA score=24 3.5% were malnourished; 31.5% were at risk of malnutrition; 65% were well-nourished
Kabir ZN(33)	Observational study, N=457 Mean age=69 Home (population in rural Bangladesh)	26% were malnourished; 62% were at risk of malnutrition
Norman K(34)	Observational study, N=112 Mean age=85 Nursing homes	19.6% were well-nourished Handgrip strength, knee-extension strength, Barthel's index and phase angle decreased with decreasing MNA
Soini H(35)	Observational study, N=178 Elderly patients At home	50% were at risk of malnutrition; 3% were malnourished
Suominen MH(36)	Cross-sectional study, N=1043 Mean age=81 Long-term care hospitals	Mean age=81 Long-term care hospitals According to the nurses: 15% were malnourished According to the MNA: 56.7% were malnourished patients considered to have normal nutrition by the nurses: 50.2% were malnourished and 46.7% were at risk of malnutrition
Wikby K(37)	Cohort study, N=127	Cohort 2: people who were newly

	Age≥65 community residential homes	admitted to these community residential homes Cohort 1: previous study performed in the same municipality 4 years earlier 32% were malnourished in Cohort 2; 38% were malnourished in Cohort 1

4.4.2 CAUSES OF AND RISK FACTORS FOR MALNUTRITION

There are several causes for malnutrition. They vary from physiologic changes of aging to pathologic conditions which affect the nutritional status.

1. **Physiologic changes of aging affecting nutrition** are discussed in Section 4.3
2. **Socioeconomic, cultural and psychological influences**

Beyond the age of 70 years several psychological, socioeconomic, and cultural factors play a significant role in maintaining an adequate diet. Depression is a fairly common and often unrecognized cause of a poor dietary intake and should always be taken into consideration when an older patient starts to lose weight, especially with no other overt cause. Bereavement also reduces appetite. Poverty, limited mobility, social isolation dependency etc. are also important risks. Studies have found that older adults who eat alone tend to lose weight more as compared to those who eat with family or relatives. Changing this behaviour has been shown to cause weight gain.(38,39) Loss of partner is a major factor. Lack of financial resources limits the range of foods

available to the older adult. Physical disability which limits mobility also adds to this. Social isolation causes loss of appetite and loss of interest towards food.

3. Secondary to pathological conditions

Gastro intestinal surgeries like gastrectomy and dysfunction from bacterial overgrowth lead to malabsorption; major nutrients affected are fat-soluble vitamins, vitamin B12 and folic acid. Food choices are limited due to inefficient mastication from ill-fitting or absent dentures. Medications and alcoholism can negatively affect nutrition. Alcohol replaces foods with empty calories and can also interfere with absorption of nutrients like folic acid. Drugs impair nutrient utilization e.g. barbiturates impair absorption of folic acid, and hence nutrient supplementation is required when such drugs are being used. Diseases can also increase requirements for nutrients and along with drugs, will lead to deficiency of micronutrients. (40,41)

4. Medications affecting nutritional status (42–44)

Table 3 Medications Affecting Nutritional Status

MECHANISM	**DRUGS**
DECREASED APPETITE	Antibiotics ,digoxin, amiodarone, spironolactone, cimetidine, amitriptyline, cyclophosphamide, indomethacin, morphine, fluoxetine
ALTERED TASTE AND SMELL	Amlodipine, Ciprofloxacin, Doxycycline, Nifedipine, Diltiazem, Allopurinol, Ethambutol, Levodopa, Metronidazole, Ofloxacin, Propranolol
NAUSEA AND VOMITING	Antibiotics, Antidepressants, Aspirin, Chemotherapy drugs, Narcotic pain medicines, Iron
DIARRHOEA	Antimicrobials, laxatives, magnesium-containing

	antacids, NSAID , prostaglandins, colchicine, anti-neoplastics, antiarrhythmic drugs
FOLATE DEFICIENCY	Ethanol , phenytoin, phenobarbital, primidone, or phenothiazines
VITAMIN B12 DEICIENCY	Aminosalicylic acid, slow-release K iodide, colchicine, trifluoperazine, ethanol
VITAMIN D DEFICIENCY	Anticonvulsants
MINERAL DEFICIENCY IODIDE IRON	 Sulfonylureas and lithium Tetracycline

4.4.3 CONSEQUENCES OF MALNUTRITION

Malnutrition is associated with multiple adverse health consequences. It is an important predictor of morbidity and mortality. Malnutrition exacerbates existing medication conditions, increases the risk of complications and decreases survival time.

POORER OVERALL HEALTH AND MORTALITY

Undernutrition in the elderly is associated with several adverse health consequences, including impaired muscle function, decreased bone mass, immune dysfunction, anemia, reduced cognitive function, poor wound healing, delayed recovery from surgery, and ultimately, increased mortality (19). In the SENECA (Survey in Europe on Nutrition and the Elderly, a Concerted Action) study, subjects with MNA scores ≥24 had significantly lower mortality (odds ratio: 0.35, 95% CI: 0.18–0.66) than subjects at nutritional risk (MNA <24) (45). Beck etal found that

community-dwelling elderly malnourished subjects were 3 times more likely than nourished subjects (20.3% MNA <17 versus 7.7% MNA ≥24; *P*<.001) to be subsequently institutionalized(46). Malnourishment continues to adversely affect the elderly even after institutionalisation. Sullivan & Walls demonstrated that protein-energy malnutrition was a strong independent risk factor for in-hospital life threatening morbidity(47). Cederholm et al followed up malnourished elderly who were admitted for emergencies and found out that cumulative mortality 9 months after admission was more than double (44% in malnourished and 18% in non-malnourished; p<0.001) in the malnourished patients than in the normally nourished patients(48). Undernutrition has a prognostic impact in patients with acute medical illnesses. Davalos etal found that among patients admitted with an acute stroke, undernourished patients had an increased frequency of bed sores and infections. They also tended to have a poorer outcome including significant morbidity and death(49). Poor nutritional status is an important risk factor for developing hip fractures in the elderly. Among them, the severely undernourished tend to have a higher mortality rate also(50).

IMMUNE DYSFUNCTION

Deficits in macro- and micronutrient intakes are associated with decreased lymphocyte proliferation and an impaired immune response. Tissue maintenance and repair are dependent on the availability of protein and essential micronutrients. Protein-energy malnutrition and micronutrient deficits of zinc, selenium and vitamin B6 have been shown to exacerbate the dysregulation of the immune system among older individuals. Infectious diseases occur more frequently and with more serious consequences among persons with poor nutritional status (19).

DISABILITY

Muscle wasting, weight loss and poor appetite contribute to, and are caused by malnutrition. This significantly affects the quality of life in the elderly(19).

4.4.4 SCREENING TOOLS FOR MALNUTRITION

Table 4 SCREENING TOOLS FOR MALNUTRITION

Screening tool	**Description**	**Sensitivity**	**Specificity**
The Nutritional Risk Screening (NRS) 2002	Screening for undernutrition & estimate for disease severity (51)	39%-70%	83%-93%
The Simplified Nutrition Assessment Questionnaire (SNAQ)	4 point questionnaire (52)	81.3%-88.2%	76.4%-83.5%

SCREEN II (Seniors in the Community: Risk Evaluation for Eating and Nutrition)	17-item tool that assesses nutritional risk; includes intake, physiological barriers to eating, social/functional barriers to eating and changes in weight (53)		
The Malnutrition Universal Screening Tool (MUST)	Incorporates BMI. anorexia for 5 days due to disease and weight loss in three to six months (54)		
The Malnutrition Screening Tool (MST)	For use in acutely hospitalized patients ; also validated for use in cancer patients (55)	74%-100%	76%-93%
The Mini Nutritional Assessment (MNA)	18 point questionnaire (51)	>83%	>90%

4.4.5 MINI NUTRITIONAL ASSESSMENT

The Mini Nutritional Assessment (MNA) is a well validated tool for providing a single, rapid assessment of nutritional status in elderly patients. It can be used in clinics, hospitals, and nursing homes(56). Developed nearly 20 years ago, it originally comprised of 18 questions, while the recent MNA SF (short form) consists of 6. The aim of the MNA is to rapidly screen the risk of malnutrition and to permit early nutritional intervention when needed. This was developed in 1989 IAGG by Bruno Vellas (Toulouse University Hospital, France) and Yves Guigoz (Nestle Research Centre ,Switzerland).

VALIDATION OF MNA

The MNA was initially validated in a cohort study conducted in Toulouse, France, between 1990 and 1991. It included more than 150 healthy, frail and acutely ill elderly patients (57). Subsequently, the MNA was validated in the New-Mexico Aging Process Study (NMAPS)(58). It was a longitudinal survey on nutrition and aging by the Nestle Research Centre in Lausanne (Switzerland) in 2001.The original validation study on the full MNA demonstrated the MNA had a sensitivity of 96%, specificity of 98% and positive predictive value of 97% compared to clinical status(56)

Table 5 Studies showing sensitivity and Specificity of MNA

MNA	**SENSITIVITY**	**SPECIFICITY**
Harris et al.(59)	89%	90%
Ferreira et al.(60)	89%	82%
Elkan et al (61)	84%	36%
Kuzuya et al (62)	81%	86%
Delacorte et al (63)	100%	74.3%
Visvanathan et al (64)	89.5%	87.5%
Guigoz et al(65)	96%	98%

From 1994, the MNA has been used in hundreds of studies, translated into more than 20 languages and has been used for nutritional evaluation in more than 200 scientific publications. In 2001, a short form of the MNA (MNA-SF) was developed in collaboration with L.Z Rubenstein.(66) For full MNA questionnaire, kindly refer annexure.

MNA correlates well with biochemical markers of malnutrition (67) It helps in identifying people at risk of malnutrition even before significant changes occur in weight or serum albumin (68).

MNA AS A DIAGNOSTIC TOOL

Using the MNA score subjects are categorized as malnourished (<17), at risk of malnourishment (17–23.5) or well nourished (>23.5)(Figure 10)

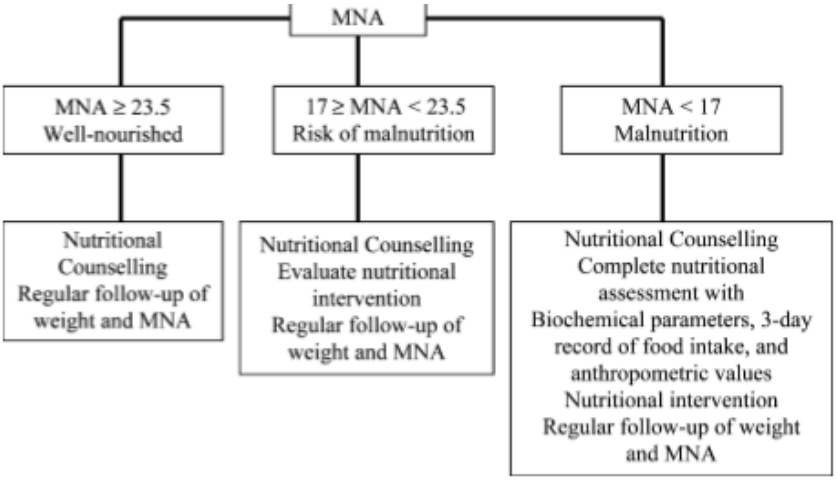


Figure 10 MNA SCORING

The MNA is useful for follow-up also. The clinicians are able to understand where the patient loses points while performing the MNA. Targeted corrective measures can be given by identifying these specific areas of need.

4.4.6 TREATMENT OF MALNUTRITION

After determining the nutritional status, targeted specific goals and objectives are formulated. The interventions include, nutritional counselling, high caloric diet, oral supplementation and appetite stimulants. When an underlying

cause for weight loss is identified, like depression, dental problems, or medical illness, it should be addressed first.

According to the The *Haute Autorité de santé* (HAS) - or French National Authority for Health guidelines nutritional support of malnourished elderly of 2007 the objective of nutritional support in malnourished elderly subjects is to achieve an energy intake of from 30 to 40 kcal/kg/day and a protein intake of from 1.2 to 1.5 g of protein/kg/day(69).

Table 6 Treatment of Malnutrition

Risk factor	**Intervention strategies**
Loss of appetite	Check drug prescription Personally chosen food Fortified menu Appetizer
Chewing problems	Dental care, Oral hygiene Mushy food
Swallowing problems	Speech therapy Tube-feeding/PEG
Difficulties preparing food	Physical therapy Nursing assistance
Immobility	Physical therapy Feeding assistance
Chronic pain	Analgesics
Depression	Check medication Medical treatment Counselling
Social isolation	Social service

Increasing the oral intake - this is the mainstay of treating malnutrition. This involves identifying and addressing specific medical, social and psychological factors.

Supplementation of specific nutrients – proven deficiencies of micronutrients should be addressed through pharmaceutical supplementation and food fortification. Supplementation of calcium, vitamins D and B12 etc. have been proven to have beneficial effects(14).

Enteral nutrition - oral liquid supplements with high energy density and high-quality proteins can be used in elderly with feeding difficulties especially those who require tube feeding. Nasogastric tube administration is the commonest form of enteral feeding and is frequently used in hospital and even community settings. Percutaneous endoscopic gastrostomy (PEG) is indicated in elderly who require long term enteral feeding(14).

Parenteral nutrition: is used only when the gastrointestinal tract is not functional and in a hospital setting(69).

Nutrition is influenced by cognitive function of the patient. Home-based programmes of nutritional education for caregivers of Alzheimer's patients have shown positive effects on weight and cognitive function.(70) Nutritional interventions also reduce morbidity and mortality in Alzheimer's patients (71,72)

4.5 FRAILTY

Frailty is defined as a syndrome characterized by loss of biologic reserve resulting in increased vulnerability to minor stressors and risk for adverse outcomes, including disability, hospitalization, and death. It results from aging associated decline and reduced reserve in multiple physiologic systems. It is inter-related, but not synonymous, with comorbidity and disability. Frail elderly persons are vulnerable to increased risk of dependency in activities of daily living, hospitalization, institutionalization, and dying when exposed to stress.

The term was first used by Brocklehurst (73), and it is analogous to “failure to thrive” in young children . There is compromised ability to cope with every day or acute stressors. There is current consensus that physical frailty is potentially reversible. There is no universally agreed definition for frailty, but a consensus statement in 2012 described it as a medical syndrome (17,74) .Frailty is considered the core of geriatric medicine.

4.5.1 EPIDEMIOLOGY OF FRAILTY

GLOBAL EPIDEMIOLOGY

There are many epidemiologic studies of frailty, using a variety of frailty measures. The prevalence varies according to the tool used for defining frailty and population studied. The prevalence in several studies in the United States ranges from 4 to 16 percent in men and women aged 65 and older. It was 43 percent in case of older patients with cancer(75,76). In the Survey of Health, Aging and

Retirement in Europe (SHARE) study, which is the largest survey performed in Europe and Israel, including more than 85,000 individuals aged 65 and above conducted in 19 countries from Europe and Israel, the prevalence of frailty was determined. Frailty was calculated using an adapted version of Fried's criteria of physical frailty. The prevalence of frailty was 17%, varying from 5.8% in Switzerland to 27.3% in Spain. The prevalence of prefrailty was considerably higher in Germany (34.6%) and Spain (50.9%)(77).

INDIAN EPIDEMIOLOGY

There is a paucity of large epidemiological studies showing the prevalence of frailty in India. In one study conducted across 14 higher income countries and six lower income countries, including India, which compared frailty in older adults the level of frailty was higher in the higher income countries than in the lower income countries. It was attributed to a survivor bias, where health systems and social support allow people in wealthier countries to live longer despite higher levels of frailty. (77) In one hospital based study , among 250 individuals, the prevalence of frailty was estimated to be 33%(78) . In a large population study, across 6 countries India was found to have a prevalence of frailty of 55.5% , based on a frailty index which was constructed as the proportion of deficits in 40 variables(79)

4.5.2 PATHOPHYSIOLOGY OF FRAILTY

Frailty is multifactorial. With aging and as a result of specific diseases there is dysregulation of various systems in the body including immune system, endocrine system, stress and energy response system. This leads to physiologic impairment and clinical frailty. Age related loss of skeletal mass or Sarcopenia is also an important physiologic component of frailty

ENDOCRINE SYSTEM

Age related hormone changes are an important factor for the development of frailty. There is decrease in growth hormone and IGF -1(80). In a cohort study among community dwelling older women this was associated with decreased strength and mobility (80). There is also a decrease in dehydropeiandrosterone sulfate (DHEAS) , which plays an important role in maintaining muscle mass(80). There is also a decrease in sex steroids and vitamin D, whereas cortisol levels increases. This affects the skeletal muscle and immune system.

IMMUNE SYSTEM

There is a strong correlation between frailty and inflammatory markers(81). Serum levels of IL6 and CRP are elevated in frail older adults. IL 6 acts as a transcription factor and signal transducer. It adversely affect appetite, adaptive immunity, skeletal muscle and cognition. Frail elderly are less likely to mount an adequate immune response after influenza vaccine(82)

OTHER SYSTEMS

There is dysregulation of the autonomic nervous system , renin angiotensin system and mitochondrial function which contributes to the development of frailty.

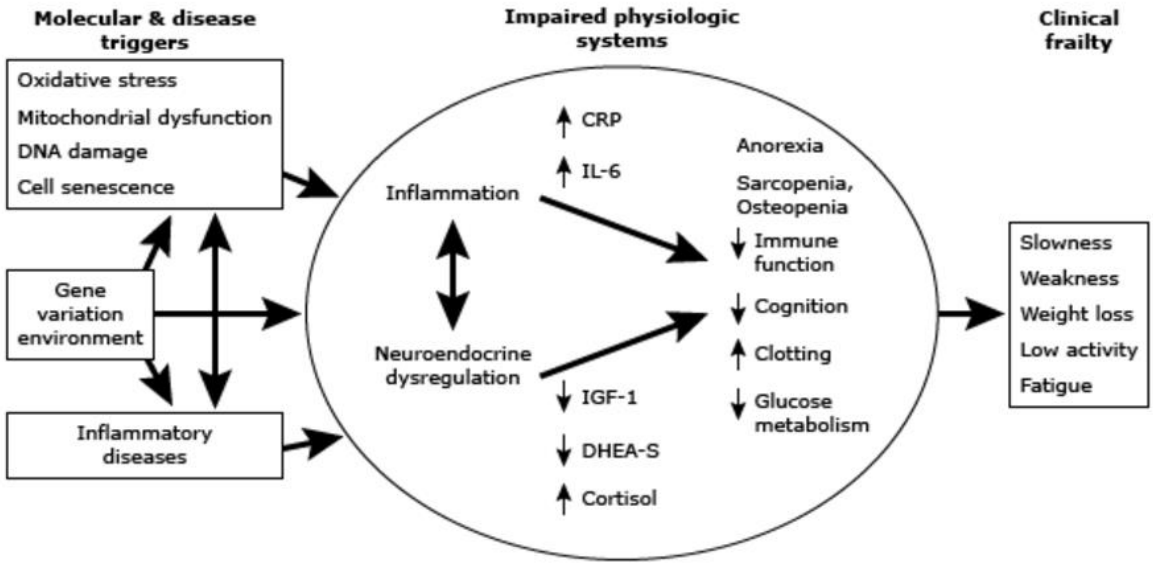


Figure 11 PATHOPHYSIOLOGY OF FRAILTY

4.5.3 CONCEPTS OF FRAILTY

Frailty is considered by some as a primary condition, related to aging alone, or as secondary to other conditions. These two concepts include: "physical" or "phenotypic" frailty versus "deficit accumulation" or "index" frailty . Majority of screening tools have been based on these concepts.

"Physical" Or "Phenotypic" Frailty

Fried et al. described frailty as a medical syndrome(17) . It is considered a unique pathophysiological process where there is diminution of physiologic

function and eventually breakdown of homeostatic mechanism. The depletion of reserves is caused by dysregulation of multiple systems with aging and diminuted effectiveness of interconnections. As one ages, the range of adaptive strategies also progressively decreases.

"**Deficit Accumulation" Or "Index" Frailty**

Rockwood and Mitnitski conceptualize frailty as a cumulative burden of physical and psychological illness, disability, and social factors that puts an individual at increased risk for additional adverse outcomes (83). Here multiple comorbidities and disabilities of the patient were added together and an overall frailty score was determined. Higher the value, worse the outcome. The frailty index was reproducible and highly correlated with five year mortality

4.5.4 SCREENING TOOLS FOR FRAILTY

There are multiple frailty assessment tools. In a systematic review of 22 articles addressing the definition of frailty, commonly used measurements for frailty screening were physical function, gait speed, and cognition(84). The most commonly cited frailty screening tool is the Physical Frailty Phenotype (also known as the Fried or Hopkins Frailty Phenotype). This tool was developed based on observations of progressive weakness and declines in activity in older adults most vulnerable to adverse outcomes and has been validated in the Cardiovascular Health Study (CHS), involving over 5000 men and women aged ≥65 years(17)

- Single item surrogate assessments of frailty include Timed up and go and Hand grip strength. In a prospective cohort of patients undergoing major surgery, patients whose TUG > 15 secs were more likely to be discharged to nursing home 67% vs 8% OR 13 (CI 5.1 – 33). Hand grip strength was inversely associated with all-cause mortality(85)

- Short scales

    - SPPB(short physical performance battery) (Annexure 11.14)

      It includes balance test, chair rise test and 5m gait speed test. . A cohort study has shown SPPB as an independent predictor of long-term survival of older subjects hospitalized for decompensated HF (86).

    - Frail scale(87)

        - **F**atigue ("Are you fatigued?")
        - **R**esistance ("Can you climb one flight of stairs?")
        - **A**mbulation ("Can you walk one block?")
        - **I**llnesses (greater than five)
        - **L**oss of weight (greater than 5 percent)

      "Yes" to three or more questions indicates frailty. "Yes" to one or two questions indicates pre-frailty.

    - The Study of Osteoporotic Fractures (SOF) frailty tool .(88)

Frailty is defined as the presence of at least two of three components:

- Weight loss of 5 percent in last year

- Inability to rise from a chair five times without use of arms
- A "no" response to the question "Do you feel full of energy?"

- Phenotypic frailty – Fried (Annexure 11.18)
- PRISMA questionnaire (Annexure 11.16)
- Clinical Frailty Scale (Annexure 11.17)

It is a rapid frailty screening tool that is scored between 1 (very fit) and 7 (severely frail) based on self-report of comorbidities and the need for help with activities of daily living (ADLs)

- British Geriatric society Guidelines(89)
  - It recommends assessment of the elderly for presence of frailty at all encounters with health care workers. It includes Gait speed, the timed-up and-go test and the PRISMA questionnaire
  - Edmonton frail scale in recommended for elective surgery
- Rockwood Frailty Index(90)

The deficit accumulation or index approach to measuring frailty is based on the accumulation of illnesses, functional and cognitive declines, and social situations that are added together to calculate frailty. It requires answering 20 or more medical and functional-related questions. The higher the number of deficits, the higher the frailty score.

- Edmonton frail scale Annexure (11.18)

OPERATIONAL DEFINITION OF FRAILTY

The Cardiovascular Health Study (CHS) frailty scale,, is the most widely used measure of frailty. Fried et al used data from cardiovascular health study and frailty was defined with the help of five criteria (17).The frailty phenotype is defined as meeting three or more of the following five criteria. Prefrailty is defined as one or two of these characteristics, and not frail as having none.

- Weight loss (≥5 percent of body weight in last year
- Exhaustion (positive response to questions regarding effort required for activity) (Annexure 11.6)
- Weakness (decreased grip strength) (Annexure 11.4)
- Slow walking speed (gait speed) (>6 to 7 seconds to walk 15 feet) (Annexure 11.5)
- Decreased physical activity (Kcals spent per week: males expending <383 Kcals and females <270 Kcal) (Annexure 11.7)

4.5.5 CONSEQUENCES OF FRAILTY

Frailty is associated with increased morbidity and mortality. In a cross sectional study done in six US centres , mortality was twice as high for frail compared with robust men (HR 2.05; 95% CI 1.55-2.72) (76).In the longitudinal Women's Health Initiative Observational Study, baseline frailty was an independent predictor for risk of death (hazard ratio (HR)=1.71, 95% confidence interval (CI)=1.48-1.97), hip fracture (HR=1.57, 95% CI=1.11-2.20), hospitalizations (OR=1.95, 95% CI=1.72-2.22) and ADL disability (odds ratio

(OR)=3.15, 95% CI=2.47-4.02). In this study there was adjustment for demographic characteristics, health behaviours, disability, and comorbid conditions(76). In a secondary analysis of SHARE study, mortality was best predicted by the Frailty Index and Edmonton scales and death rates were three to five times higher in cases described as frail compared with those not described as frail (91)

Frailty predicted adverse outcomes related to kidney transplantation and general surgery interventions. In a prospective study of 594 patients (age 65 years or above) which looked into surgical outcomes in frail patients : frailty was associated with an increased risk for postoperative complications (intermediately frail: odds ratio [OR]2.06; 95% CI 1.18-3.60; frail: OR 2.54; 95% CI 1.12-5.77). There was increased length of stay (intermediately frail: incidence rate ratio 1.49; 95% CI 1.24-1.80; frail: incidence rate ratio 1.69; 95% CI 1.28-2.23), and higher chance of discharge to a skilled or assisted-living facility (intermediately frail: OR 3.16; 95% CI 1.0-9.99; frail: OR 20.48; 95% CI 5.54-75.68) (92)

Older people living with frailty are at risk of adverse outcomes such as dramatic changes in their physical and mental wellbeing after an apparently minor event which challenges their health, such as an infection or new medication. The purpose of the BGS guidance was to advise about action which can be taken to prevent these adverse outcomes and help people live as well as possible with frailty.

4.5.6 TREATMENT OF FRAILTY

Treatment of frailty needs a multidisciplinary approach. This includes nutritional intervention, physical therapy and management of other medical problems.

NUTRITIONAL INTERVENTION

Baldwin etal in a systematic review found that providing nutritional supplements along with dietary advice was more effective for weight gain than advice alone(93). Providing **high protein supplements** has been widely studied. The PROT-AGE study by the European Union Geriatric Medicine Society recommends an daily protein intake of 1.0 to 1.3g/kg body weight; to increase to 1.2-1.5g during acute of chronic illnesses(94). In a community based randomised control study conducted in South Korea among low socioeconomic status elderly protein-energy supplementation reduced the progression of functional decline. In this trial 87 frail community based elderly with MNA score < 24, mean age 78 years and low socioeconomic status were given 400 ml of liquid protein supplement (400 kcal, 25 gm protein). After 12 weeks, SPPB declined by 12.5% in control group and was stable in the supplement group and TUG score decreased by 11.3% in controls as compared to increase of 7.2% in nutrition group. (95)

Vitamin D deficiency is an independent risk factor for frailty. In a prospective cohort study of 4203 older men aged 70-88 years in Perth, Western Australia, hypovitaminosis D was associated with prevalent and incident frailty . Low 25(OH)D was associated with increased prevalent frailty (odds ratio, 1.96;

95% confidence interval [CI], 1.52 to 2.52) and after a mean period of 5.3 years, the adjusted odds ratio of being frail at follow-up for men with low vitamin D and having no frailty at baseline was 1.56 (95% CI, 1.07 to 2.27) (96). There are several other studies establishing the strong correlation between vitamin D and frailty(97–99). Vitamin D supplementation has been found to an effective strategy to combat frailty especially for skeletal manifestations which are grouped together as hypovitaminosis D (HVD) osteopathy(100). Vitamin D plus calcium improves balance, reduces falls, and lowers the risk of fractures, which may lower the risk for reduced walking speed and inactivity. Daily administration of 800 IU of Vitamin D3 with 1000mg Calcium improved postural sway and quadriceps strength thereby reducing the risk of fall(100).

Carotenoids are believed to be antioxidants and their supplementation has been found to improve frailty in the Women's Health and Aging Study (WHAS)(101).

Creatine is the amino acid substrate of creatine kinase enzyme and helps to re-phosphorylate ADP to ATP primarily in the skeletal muscle. Creatine supplementation has been found to significantly increase fat-free mass, muscle strength, gait and balance(100).

PHYSICAL THERAPY

A combination of aerobic, strength, balance, and flexibility exercises that focused on walking and complemented the program with lower extremity strengthening exercises, followed by lower extremity stretching exercises has been

found to improve frailty. Tai chi and cobblestone walking also have been found to be effective(102). In a meta analysis of 19 trials, wwhen compared with control interventions, exercise of at least 45 min twice weekly was shown to improve normal gait speed (mean difference [MD]=.07m/s; 95% confidence interval [CI], .04-.09), fast gait speed (MD=.08m/s; 95% CI, .02-.14), and the Short Physical Performance Battery (MD=2.18; 95% CI, 1.56-2.80)(103) . In a systematic review of 20 randomized controlled exercise trials in frail older adults, majority of exercise programmes were effective in all but one. Half of the studies evaluated multicomponent exercise programmes including resistance, endurance, balance and flexibility exercises. Most exercises programs were conducted 3 times a week. The review concluded that older adults with different levels of abilities could improve their functional performance by regular exercise training(104) .

PHARMACOLOGICAL THERAPY

Appetite stimulants like Megestrol acetate, a progestational agent(105) and Dronabinol have shown promising results to improve weight gain health-related quality of life; but have to be used with caution in the elderly.

Anabolic agents have been tried. **Growth hormone** and **Testosterone** have been found to improve skeletal muscle mass and frailty. Other anabolic drugs like **Oxandrolone** and **Nandrolone** are being tried in older adults. **Ghrelin** also is on long-term trial(100).

MANAGEMENT OF OTHER MEDICAL PROBLEMS

Depression is a common and reversible cause of weight loss and frailty in the elderly. **Dementia** and frailty are also very closely linked. Assistance and supervision along with medications addressing dementia will improve frailty. **Impaired vision and hearing** also contribute to frailty and need to be addressed.

4.6 MALNUTRITION AND FRAILTY

As frailty is a biologic syndrome due to multisystem decline in physiological reserves, a large number of direct, indirect, and interacting risk factors are involved in its causation(106),They include poor socioeconomic status, living alone, comorbidity, specific chronic diseases, heart failure, diabetes, anemia, cognitive impairment ,depression, low cholesterol, and immune markers of chronic inflammation { C-reactive protein (CRP) , interleukin-6 (IL-6) } poor nutrition such as micronutrient deficiency, and obesity (107). Malnutrition can exaggerate the age-associated loss of muscle mass and strength. It plays an significant role in the development of sarcopenia and consecutively physical impairment (108), which both are substantial elements of the frailty syndrome.

Frailty and undernutrition are not similar. While people who are undernourished are more likely to be frail, there is considerable overlap between these conditions. The MNA nutritional screening tool has been proposed as a possible screening tool for frailty also.

In a cross sectional study, done in community-dwelling older adults in Germany, frailty was strongly associated with malnutrition. 46.9% of frail, 12.2% of pre-frail and 2.2% of non-frail participants were at risk of malnutrition.

4.7 RATIONALE FOR THE STUDY

There have been several studies to assess frailty in malnourished individuals. However, data from India is scarce. The aim of this study is to identify the correlation between malnutrition and frailty and its components. Performing the MNA on all outpatients may not be feasible due to time constraints while certain components of frailty such as hand grip and gait speed can be done easily in an outpatient clinic. Therefore, better knowledge of components of frailty and its association with malnutrition will assist in screening individuals for malnutrition in the outpatient setting. These high risk patients need to be followed up and advised regarding adequate nutrition and regular exercise to prevent morbidity and mortality.

5 MATERIALS AND METHODS

5.1 STUDY DESIGN

Prospective cross-sectional study over a period of 4 months

5.2 SETTING

This study was conducted in the Christian Medical College, a 2695 bedded teaching institute in South India. Patients who visited the Geriatrics outpatient department were included in the study.

DURATION OF THE STUDY

The study period was for 4 months - from May 2016 to August 2016

STUDY PARTICIPANTS

Elderly patients 60 years and above who visited the Geriatrics outpatient Department, fulfilling the inclusion and exclusion criteria

5.3 ELIGIBILITY CRITERIA

INCLUSION CRITERIA

Subjects 60 years and above from any state in India, attending Geriatrics out-patient clinic, Christian Medical College Vellore.

1. Capable of giving informed consent
2. Ambulatory Patients

EXCLUSION CRITERIA

1. Subjects who are acutely ill

2. Subjects with functional inability to do the tests – e.g. subjects with severe Chronic Obstructive Lung Disease/Congestive Cardiac Failure/decompensated liver disease/chronic kidney disease/severe osteoarthritis/severe peripheral neuropathy/visual problems/neurodegenerative disorders/ Severe anemia / Stroke with significant motor weakness / Critical mitral or aortic stenosis End stage renal failure /Advanced Malignancy

3. Subjects with cognitive impairment, because of which they cannot comprehend the

facets of the test.

4. Subjects who decline to give consent.

5.4 PRIMARY OUTCOME

1. To study the correlation between nutritional status and frailty in the elderly.

5.5 SECONDARY OUTCOMES

1. To study correlations between individual components of frailty assessment and the nutritional status of the elderly

2. To study association between baseline characteristics and nutritional status

3.To study association between baseline characteristics and frailty

5.6 SAMPLE SIZE CALCULATION

The prevalence of malnutrition varied from 5.8 % to 50%, based on various previous studies (25,27,28,109,110).For calculating sample size, the study done in rural south India was considered. The required sample to show that there is about 14% malnutrition (Ref: Malnutrition in free-living elderly in rural south India: prevalence and risk factors Aditya Vedantam*, Vijay Subramanian, Nicholas Vijay Rao and KR John (Public Health Nutrition: 13(9), 1328–1332) among the elderly was found to be **185 subjects** with 5% precision, 95% confidence limits.

Formula:

$$n = \frac{Z^2_{1-\alpha/2}\, p\,(1-p)}{d^2}$$

Where,

p : Expected proportion

d : Absolute precision

1- α/2 : Desired Confidence level

a.

b. Where, p = 0.14, d = 5%

c. *Reference for above formula: Lemeshow S, Hosmer DW, Klar J, Lwanga SK. Adequacy of Sample Size in Health Studies. John Wiley and Sons, 1990.*

Sampling:

Sampling was done by systematic random sampling. Everyday a list of all subjects attending the outpatient clinic was obtained from the Medical records officer and subjects were stratified by their age 60-69, 70-79, 80 and above. Some outliers were considered individually. The first observation was selected randomly and every third subject was selected from then onwards. This procedure was done every day in the OPD. After excluding subjects not fulfilling the exclusion criteria. informed consent was obtained. Those subjects were included for the final analysis.

SOURCES OF INFORMATION

1. Detailed history from the study participants

2. Study participants' relatives

3. Measurements

Clinical examination by Principal investigator

Mid arm circumference

Calf circumference

Hand grip strength estimated by the Hand held dynamometer

Gait speed

Timed Up and Go

4. Laboratory tests–Hemoglobin, Albumin.

DATA COLLECTION

The data collection was done in the Geriatric Outpatient department, after obtaining written informed consent. Data was collected and collated under the following headings.

1. Demographic profile

2. Socioeconomic status

3. Mini Nutritional Assessment

4. Frailty assessment according to Fried's Index

5. Co-morbidities Charlson comorbidity index

6. Medications the subject is taking

7. Polypharmacy (>5 drugs)

8. Barthel's Index

9. Timed Get Up and Go

10. Body Mass Index

11. Gait speed

12. Min COG

13. PHQ2 screening

14. Haemoglobin with MCV

15. Albumin

5.7 METHODOLOGY

The data collection was done in the Department of Geriatrics, CMCH Vellore, after obtaining written informed consent. Subjects who provided consent for the study , underwent an interview and data regarding demographic profile and socioeconomic profile recorded using the Kuppuswamy index (annexure 10.8) were collected. Nutritional assessment was done using the Mini Nutritional Assessment [MNA] (Annexure 10.1). Height, weight, mid arm circumference (Annexure 10.2) and calf circumference (Annexure 10.3) of the subjects were measured and Body Mass Index (BMI) calculated. Co-morbidities were assessed and the Charlson co-morbidity index was calculated (Annexure 10.9). Significant past medical, surgical and drug history were tabulated. Polypharmacy, defined as the use of multiple medications, usually more than 5 drugs was assessed(111).

Geriatric assessment was done using Mini COG test (Annexure 10.10) and Barthel's index (Annexure 10.12) for activities of daily living.

Frailty was assessed using the Fried or Hopkins Frailty Phenotype .It has five questions.

1. Weight loss – self assessment of loss of weight of >5% body weight in the last year was considered a positive response
2. Exhaustion – CES-D questionnaire (Annexure 10.6)
3. Hand grip strength using the Jamar dynamometer (Annexure 10.4)
4. Gait speed (Annexure 10.5)
5. Physical activity – Minnesota leisure time physical activity index (Annexure 10.7)

Subjects were classified based on their score as 0= healthy, 1-2 = pre-frail and 3 or more = frail.

Timed get up and go test also was performed (Annexure10.11). BMI was measured. The results were analysed for correlation between prevalence of frailty, its components and presence of poor nutrition.

5.8 STASTISTICAL ANALYSIS

The data was entered in Epidata software .Categorical variables were summarised using counts and percentages. Quantitative variables were summarised using mean and standard deviation or median and IQR. Chi square test was used to compare the proportions between categorical variables. One way analysis of variance test and Kruskal Wallis test was used for the comparison of three groups.

Pearson correlation coefficient test was used to find the correlation between quantitative variables. For all the analysis, 5% level of significance was considered to be significant. All the statistical analyses were done using stata/ic 13.1.

FUNDING

FLUID research grant, Christian Medical College Vellore

INSTITUTIONAL RESEARCH BOARD APPROVAL AND ETHICAL CONSIDERATIONS:

In this observational study there were no ethical issues. The study protocol was explained to the participants/relatives and a written and informed consent was obtained before subjecting them to interview and examination. Institutional Research Board (IRB) approval was obtained (IRB Min. No. 10026 (OBSERVE) dated 04/04/2016).

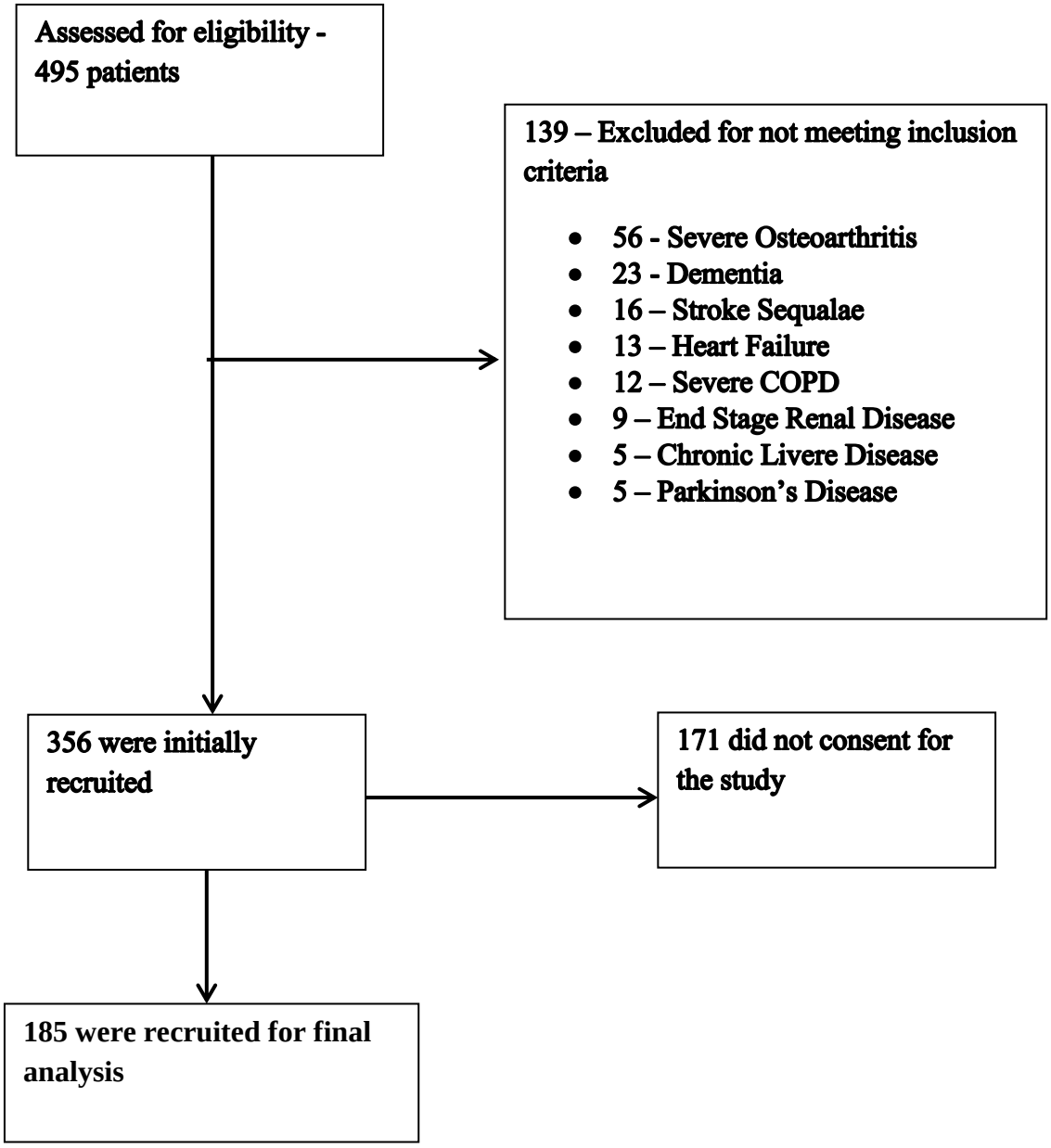


Figure 12 STROBE DIAGRAM

6 RESULTS

In this study, 5802 patients visited the Geriatric outpatient department during the study period. Among these patients 356 patients were selected by sampling and qualified for recruitment as they fulfilled the inclusion criteria and exclusion criteria. Out of the 356 subjects, 185 gave consent for the study and were included in the final analysis.

6.1 DEMOGRAPHICS

Table 7 **Baseline characteristics**

Baseline characteristics	**No.(Percentage)**
Age in years (mean & SD)	67.73 ± 5.66
60-69	119(64.32)
70-79	48(24.95)
80 -89	17(9.19)
90 and above	1(0.54)
Gender	
Men	112 (60.54)
Women	73 (39.45)
Height (mean + SD)	
Men	164.49 ± 16.65
Women	149.27 ± 16.63
Weight (mean + SD)	
Men	62.88 ± 12.79
Women	53.99 ± 12.78
BMI (mean + SD)	
Men	23.20 ± 3.52
Women	24.15 ± 5.05

Socio-economic status	
(Revised Kuppuswamy scale 2014	
Upper class 25 – 29	31 (16.76)
Upper middle class 16 – 25	64 (34.59)
Lower middle class 11- 15	44 (23.78)
Upper lower class 5 – 10	34 (18.37)
Lower class <5	12 (6.49)
Comorbidities	
Hypertension	102 (55.13)
Diabetes mellitus	83 (44.86)
Ischemic heart disease	14 (7.57)
Cerebrovascular accident	3 (1.62)
Dyslipidemia	52 (28.10)
COPD	17 (9.19)
Charlson comorbidity score	
0	55 (29.74)
1	66 (35.66)
2	50 (27.02)
3	14 (7.56)
Polypharmacy	47 (25.41)
Antidepressant use	26 (14.05)
Mini COG test - Cognitive impairment	
Present	26 (14.05)
Absent	159 (85.95)
Barthel's ADL index (average)	19.84
Hand grip	
Normal	3
Weak	182
Timed get up and go	
Freely mobile (<10 seconds)	118 (63.78)
Mostly independent (11-20 sec)	55 (29.73)

Variable mobility (20-29 sec)	10 (5.41)
Impaired Mobility (>30sec)	2 (1.08)
Gait speed	
Normal	131 (70.81)
Reduced	54 (29.19)
Serum Albumin	4.31 ± 0.57
Hemoglobin	12.79 ± 1.56
Men	13.30 ± 1.45
Women	11.99 ± 1.47
Mean corpuscular volume	86.81 ± 4.95
Depression screening - PHQ2 score	
>3	3(1.62)

6.1.1 AGE AND SEX

There were a total of 185 patients recruited for the study. The average age of the study population was 67.73 years (SD 5.66 years). Majority of the subjects (64%) were in the 60-69 years age group, followed by 26% in the 70-79 years age group and 9% in the 80-89 years age group. 1 subject was 90 years old. (Figure 13) . In the study population 60.54% (n=112) subjects were men and 39.45% (n=73), women. (Figure 14)

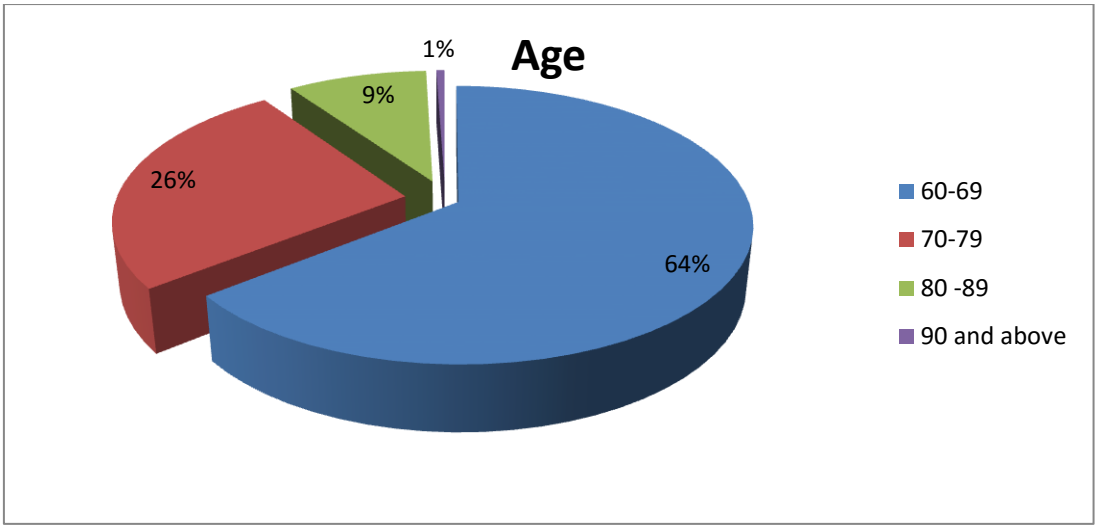


Figure 13 AGE DISTRIBUTION

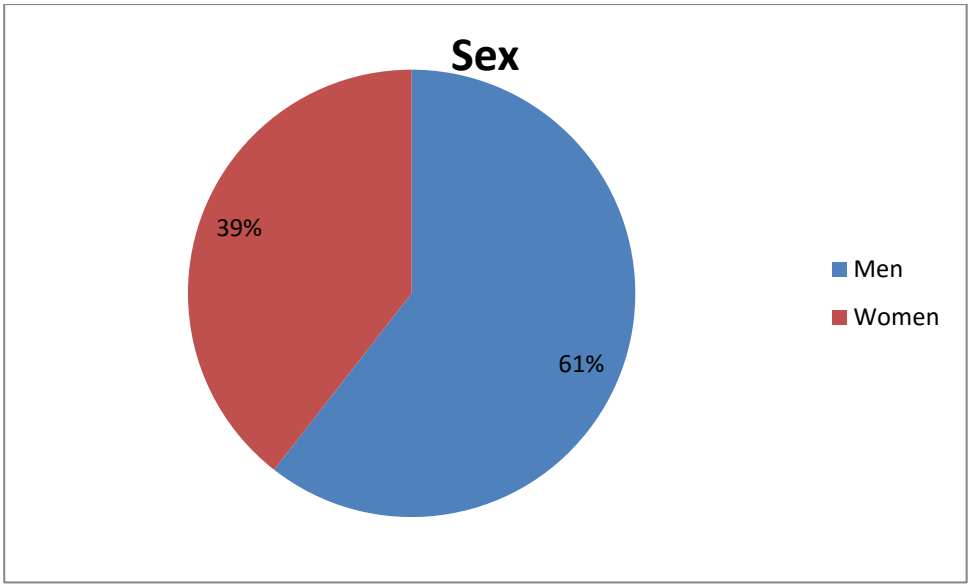


Figure 14 SEX DISTRIBUTION

6.1.2 BASELINE PHYSICAL PARAMETERS

The mean height of male subjects was 164.49 cm (SD 16.65) and of the female subjects was 149.27 cm (SD 16.63). The mean weight of men was 62.88 kg

(SD 12.79) and that of women was 53.99 kg (SD 12.78). This translated to a mean BMI of 23.20 ± 3.52 in men and 24.15 ± 5.05 in women.

6.1.3 SOCIOECONOMIC STATUS

Revised Kuppuswamy scale (2014) was used to assess the socioeconomic status. Of the 185 people 16.76% (31) were categorised as upper class, 34.59%(64) as upper middle class ,23.78% (44) as lower middle class , 18.37% (34) as upper lower class and 6.49% (12) as lower class.(Figure 15)

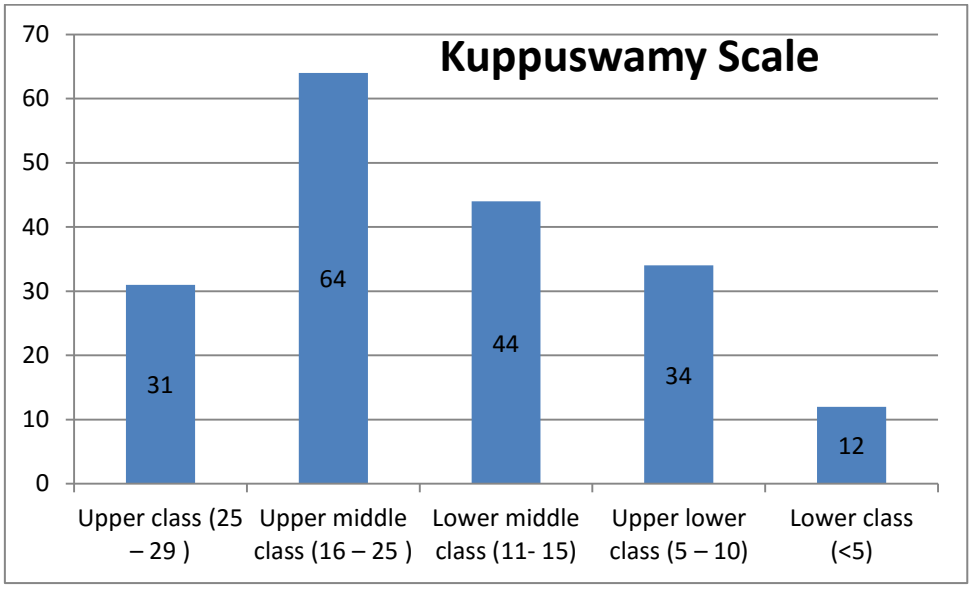


Figure 15 DISTRIBUTION OF SOCIOECONOMIC STATUS

6.1.4 COMORBIDITIES

Hypertension was the most common comorbidity and was present in 55.13% of the subjects. This was followed by diabetes mellitus in 44.86%, and dyslipidemia in 28.10%. COPD (9.19%), ischemic heart disease (7.57%) and cerebrovascular accident (1.62%) were less common among the study population. The Charlson

comorbidity score was calculated and was found to be 0 in 29.764%, 1 in 35.66% , 2 in 27.02% and with no one having a very high score. (Figure 16)

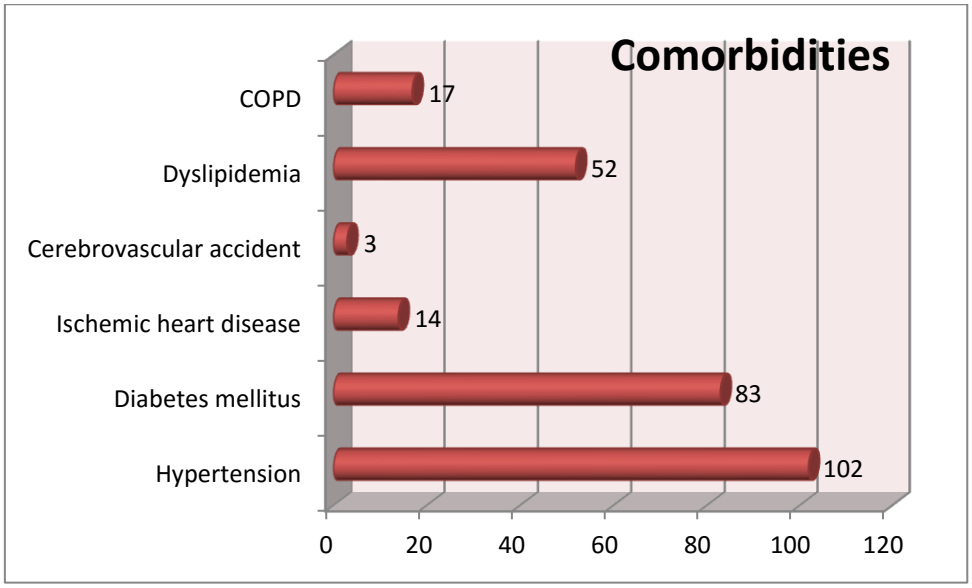


Figure 16 DISTRIBUTION OF COMORBIDIDTIES

6.1.5 MEDICATION USE

Polypharmacy was fairly common with 25.54% subjects being on more than 5 medications. The average number of medications among all the subjects was 2.81 (SD 0.71). 14.05% subjects were using some antidepressants.

6.1.6 COGNITIVE FUNCTION

Cognitive function was assessed using the Mini COG questionnaire and 14.05% were found to have cognitive impairment.

6.1.7 ACTIVITIES OF DAILY LIVING

Activities of daily living were assessed using the Barthel's ADL index which showed an average score of 19.84 which was almost normal.

6.1.8 GRIP STRENGTH

Except for 3 subjects, all the others had decreased hand grip strength when assessed using JAMAR electronic hand dynamometer. Table 3 shows the mean and standard deviation of hand grip strength in various age groups in both sexes. Compared to the standard reference used for this study (Annexure 10.4), the hand grip strength was very weak in the study population

Table 8 HAND GRIP STRENGTH

Gender	**60 – 64Yrs** **KG**	**65 – 70Yrs** **KG**	**71 – 75Yrs** **KG**	**75+Yrs** **KG**
Right **Hand** **Mean(Standard Deviation)**	*Male - 25.17(5.33)* Female -13.95 (3.84)	*Male - 21.93(5.96)* Female - 12.73(3.47)	*Male - 19.26(7.18)* Female - 11.08(2.36)	*Male - 19.09 (6.42)* Female - 9.86 (4.33)
Left **Hand** **Mean(Standard Deviation)**	*Male – 24.29 (4.41)* Female - 13.13(3.55)	*Male - 21.03(6.03)* Female - 11.79(3.64)	*Male – 17.36(6.53)* Female - 10.44(2.44)	*Male - 18.56(6.54)* Female – 8.98(3.67)

6.1.9 TIMED GET UP AND GO

The timed get up and go test (TUG) is a simple test used to evaluate mobility in people especially the elderly. It involves getting up from a chair, walking 3 meters, turning around and returning to the same chair. 63.78% of subjects were classified as freely mobile with a time <10 seconds. 29.73% were mostly independent with a timing of 11-20 seconds. 5.41% had variable mobility with a timing between 20 and 29 seconds and 2 subjects (1.08%) had impaired mobility with a time of >30 seconds. The gait speed was normal in 70.81% of the subjects.

6.1.10 INVESTIGATIONS

Baseline haematological and biochemical parameters were measured. The average haemoglobin was 12.79 (SD 1.56); 13.30 in men and 11.99 in women. The mean MCV was 86.81 (SD 4.95). The mean serum albumin was 4.31 (SD 0.57).

6.2 PRIMARY OBJECTIVE

The primary objective of this study was to assess the nutritional status in the elderly and correlation with frailty.

6.2.1 MALNUTRITION

Normal = 134	At risk = 48	Malnourished = 2

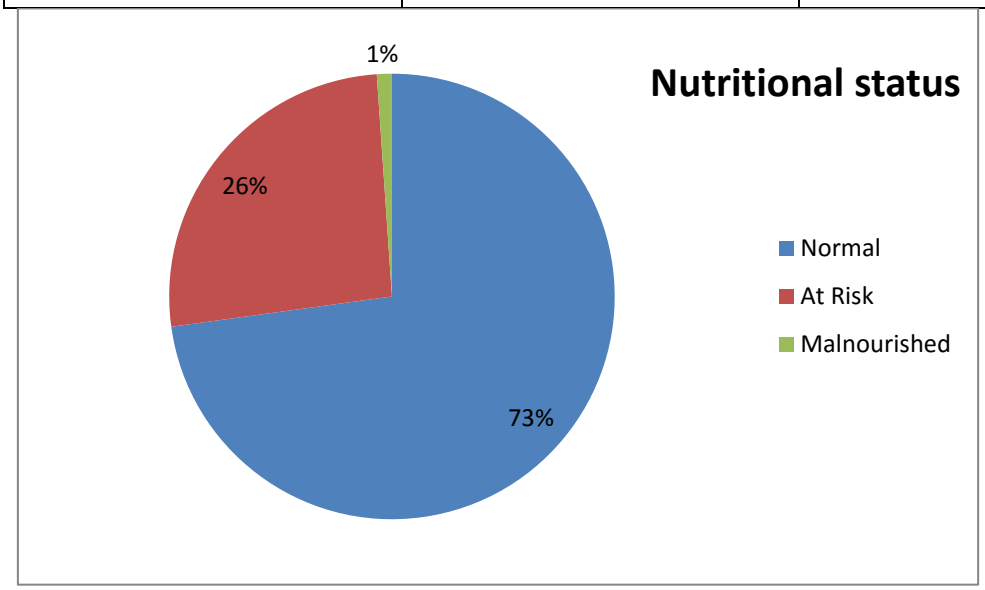


Figure 17 NUTRITIONAL STATUS

Nutritional status was assessed using the MNA scoring system. There were 2 subjects who were malnourished and 48, at risk of malnutrition. The prevalence of malnutrition in the study population was 1.09%. The prevalence of at risk for malnutrition was 26.09%. (**Figure 17**)

6.2.2 FRAILTY

Normal/healthy = 3	Pre frail =134	Frail = 47

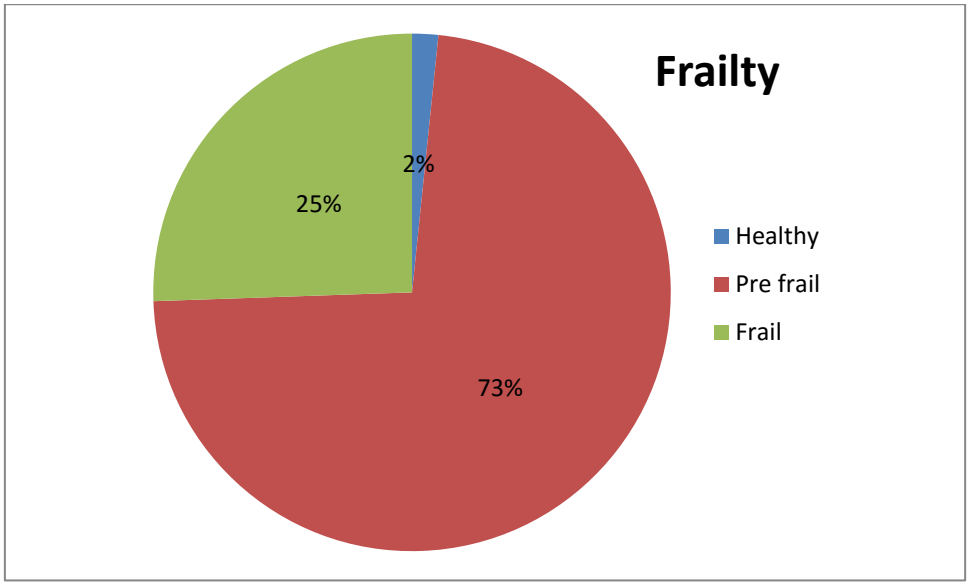


Figure 18 PREVALANCE OF FRAILTY

Frailty was assessed using the Fried's Frailty Scoring system. Only 3 subjects were found not to have any features of frailty and were classified as healthy. The prevalence of frailty in the study population was 25.54%. The prevalence of pre frailty was 72.83%. (Figure 18)

6.2.3 CORRELATION OF FRAILTY WITH NUTRITIONAL STATUS

Table 9 CORRELATION OF FRAILTY WITH NUTRITIONAL STATUS

MNA No(%)	No frail/Healthy	Pre frail	Frail	p value
Normal	2(66.67)	105(78.63)	27(57.45)	
At risk	1(33.33)	29(21.64)	18(38.3)	**0.020**
Malnourished	0(0)	0	2(4.26)	

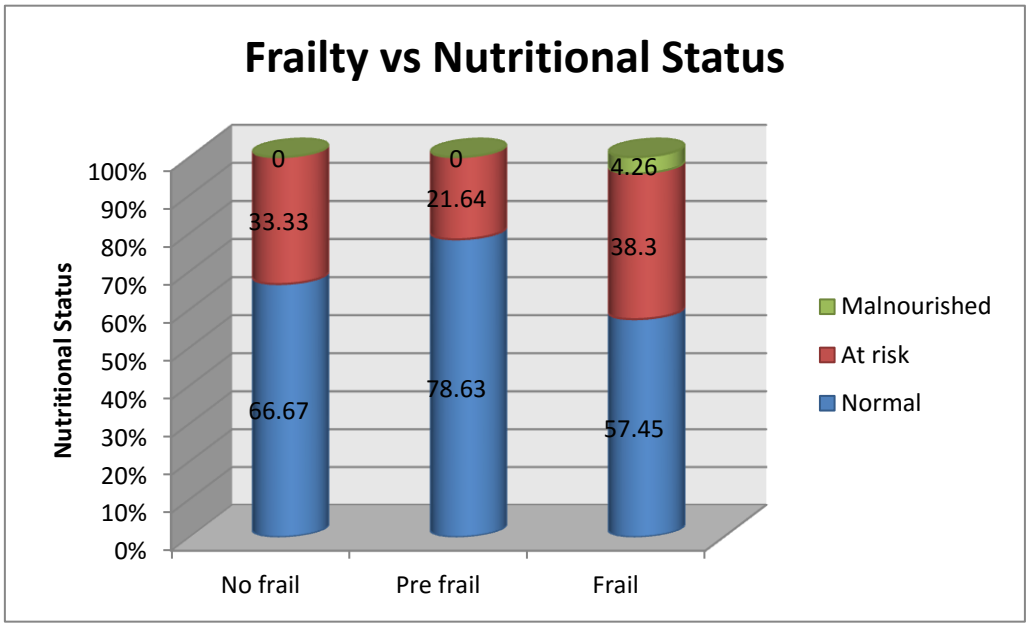


Figure 19 CORRELATION OF FRAILTY WITH NUTRITIONAL STATUS

Table 9 and Figure 19 show a statistically significant correlation between nutritional status and frailty with the p value being 0.020. This means that frailty is strongly linked to the nutritional status in the elderly. Those who are frail tend to be malnourished more than those who are pre frail or healthy.

6.2.4 CORRELATION OF NUTRITIONAL STATUS WITH FRAILTY

Table 10 CORRELATION OF NUTRITIONAL STATUS WITH FRAILTY

Frailty No(%)	Normal	At Risk	Malnourished	p value
No frail/Healthy	2(1.49)	1(2.08)	0	
Pre Frail	105(78.36)	29(60.42)	0	0.020
Frail	27(20.15)	18(37.50)	2(100)	

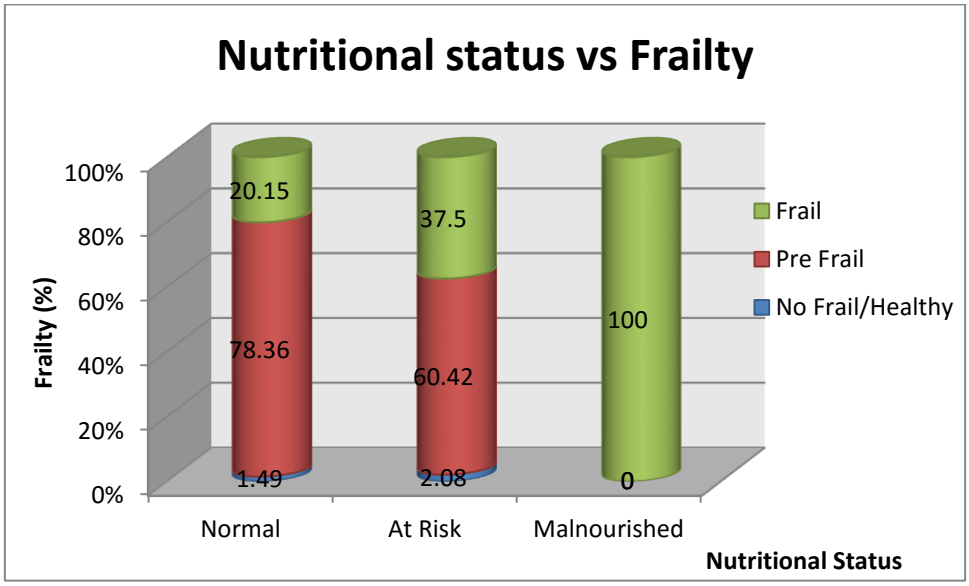


Figure 20 CORRELATION OF NUTRITIONAL STATUS WITH FRAILTY

When nutritional status was analysed in association with frailty there was a very strong correlation with a p value 0.020. This means that among the elderly, the malnourished tend be significantly more frail than theat risk and normally nourished. The at risk population was more frail than normal (37.50% vs 20.15%) (Figure 20 Table 10)

6.3 SECONDARY OBJECTIVES

The secondary objectives of this study were to study correlations between individual components of frailty assessment and the nutritional status of the elderly. Here each individual parameter of MNA and Fried Frailty Index was analyzed to find any correlation between them.

6.3.1 CORRELATION OF MARKERS OF NUTRITIONAL STATUS WITH FRAILTY

ANTHROPOMETRIC ASSESSMENT

MNA VS FRAILTY No(%)	NON FRAIL	PREFRAIL	FRAIL	P VALUE
BMI <23	2(66.67)	60(44.78)	22(46.81)	0.741
MID ARM CIRCUMFERENCE </=22CM	0	11(8.15)	13(27.66)	**0.002**
CALF CIRCUMFERENCE <31CM	2(66.67)	31(23.31)	18(38.30)	**0.046**
WEIGHT LOSS WEIGHT LOSS >1 KG	0	28(20.74)	17(36.17)	0.064

Table 11 ANTHROPOMETRIC ASSESSMENT VS FRAILTY

Mid arm circumference of <22cm had statistically significant association with frailty with a p value of 0.002.Those who are frail tend to have MAC <22 cm compared to prefrail (38.3% vs23.3%). Similarly, calf circumference < 31cm also had significant association with frailty. BMI and history of weight loss did not show any significant association.

GENERAL ASSESSMENT

Table 12 GENERAL ASSESSMENT VS FRAILTY

MNA VS FRAILTY No(%)	NON FRAIL	PREFRAIL	FRAIL	P VALUE
NOT LIVING INDEPENDENTLY	0	5(3.70)	1(2.13)	0.828
TAKES >3 DRUGS	1(33.33)	42(31.11)	18(38.3)	0.665
PRESENCE OF ACUTE STRESS	0	3(2.22)	1(2.13)	0.966
NEUROPSYCHIATRIC ILLNESS	0	0	1(2.13)	0.229
MOBILITY IMPAIRED	0	0	1(2.13)	0.229
PRESSURE SORES	0	0.74	0	0.830

Non-independent or assisted living did not show any association with frailty suggesting that elderly with a good support system, which is primarily family support in the Indian culture, protects against frailty. Taking >3 drugs regularly, presence of acute stress or any neuropsychiatric illnesses were not found be significantly associated with a higher risk of frailty.

Impaired mobility which is believed to accelerate muscle hypotrophy or the presence of pressure sores which suggest prolonged immobility were also not found to be associated with an increased risk of frailty.

DIETARY ASSESSMENT

Table 13 DIETARY ASSESSMENT VS FRAILTY

MNA VS FRAILTY No(%)	NON FRAIL	PREFRAIL	FRAIL	P VALUE
< 3 FULL MEALs/DAY	0	39(28.89)	14(29.79)	0.538
PROTEIN INTAKE <3 MARKER	2(66.67)	135(100)	47(100)	**<0.001**
FRUITS< 2 SERVINGS	1(33.33)	51(37.78)	24(51.06)	0.270
LOSS OF APPETITE MODERATE OR SEVERE	0	26(19.26)	24(51.06)	**<0.001**
FLUID <5 CUPS/DAY	0	33(24.44)	23(48.94)	**<0.001**
FEEDING DEPENDENCY	0	0	5(10.64)	**0.001**

There was a very significant association between 4 out of 6 markers of dietary assessment and frailty. Protein intake less than 3 marker showed significant association with frailty and prefrailty compared to non frail with p value <0.001. There was significant association between moderate to severe loss of appetite and frailty with a p value < 0.001. 51% of frail patients complained of loss of appetite as compared to 37% in the prefrail group. Daily fluid intake was also found to be a significant factor predisposing to frailty in the elderly. Consuming <5 cups of fluids a day showed statistically significant association with frailty with a p value of 0.004. Those who were dependent on care givers for feeding were also found to be frail more than those who could feed themselves, with a p value of 0.001.

SELF ASSESSMENT

Table 14 SELF ASSESSMENT VS FRAILTY

MNA VS FRAILTY	NON FRAIL	PREFRAIL	FRAIL	P VALUE
SELF VIEW NUTRITION NOT NORMAL	1(33.33)	11(8.15)	12(25.53)	**0.005**
HEALTH STATUS NOT BETTER	2(66.67)	45(33.33)	31(65.96)	<0.001

A self-assessment of nutritional and general health status was found to be strongly associated with frailty with p values 0.018 and 0.002 respectively. This means that a person's self-assessment of their health status has to be considered as an important factor in their health care and due importance given to addressing this factor.

6.3.2 CORRELATION OF MARKERS OF FRAILTY WITH NUTRITIONAL STATUS

Table 15 CORRELATION OF MARKERS OF FRAILTY WITH NUTRITIONAL STATUS

FRAILTY VS MNA	NORMAL NUTRITION	AT RISK	MALNOURISHED	P VALUE
WEIGHT LOSS PRESENT	10(7.46)	14(29.17)	0	**0.001**
EXHAUSTION PRESENT	11(8.21)	8(16.67)	1(50)	0.055
HAND GRIP WEAK	134(100)	47(97.72)	2(100)	0.241
GAIT SPEED <7 sec	102(76.12)	28(58.33)	0	**0.006**
LOW PHYSICAL ACTIVITY	35(26.12)	21(43.75)	2(100)	**0.009**

When the various parameters used in the Fried Frailty Scoring was analysed in relation with the nutritional status, there were some significant associations. History of loss of weight in the previous year was very strongly associated with poor nutrition with a p value of 0.001. There was significant correlation between subjects with low

physical activity and slower gait speeds <7sec, with poor nutrition, with p values 0.009 and 0.006 respectively.

6.4 BASELINE CHARACTERISTICS ACCORDING TO MALNUTRITION

Table 16 BASELINE CHARACTERISTICS ACCORDING TO MALNUTRITION

DEMOGRAPHICS	NORMAL (n=143) No(%)	AT RISK (n=48) No(%)	MALNOURISHED (n=2) No(%)	P VALUE
AGE				
60-69	69.40	50	50	
70-79	23.13	35.42	0	0.059
80-89	7.46	12.50	50	
>/=90	0	2.08	0	
SEX				
MALE	86(64.2)	24(50)	1(50)	0.217
FEMALE	48(35.8)	24(50)	1(50)	
SOCIOECONOMIC STATUS				
UPPER	25 (18.6)	5(10.4)	0	
UPPER MIDDLE	50 (37.3)	13(27.1)	1(50)	
LOWER MIDDLE	33 (24.6)	11(22.9)	0	**0.049**
UPPER LOWER	20(14.9)	14(29.2)	0	
LOWER	6 (4.5)	5 (10.4)	1(50)	
COMORBIDITIES (% present)				
HYPERTENSION (n=102)	73(54.5)	27(56.3)	2(100)	0.434
DIABETES MELITUS (n=83)	59(44)	23(47.9)	1(50)	0.889
ISCHEMIC HEART DISEASE (n=14)	8(5.97)	5 (10.4)	1(50)	**0.046**
CEREBROVASCULAR ACCIDENT(n=3)	2 (1.5)	1(2.1)	0	0.946
DYSLIPIDEMIA (n=52)	37(27.6)	13(27.1)	2(100)	0.077

COPD (n=17)	11(8.2)	6(12.5)	0	0.612
POLYPHARMACY(present)	33(24.7)	13(27.1)	1(50)	0.688
MINICOG				
COGNITIVE IMPAIREMENT	11 (8.2)	15(31.3)	0	**<0.001**
NORMAL	123(91.8)	33(68.8)	2(100)	
CLOCK DRAWING TEST				
NORMAL	104(77.6)	24(50)	1(50)	**0.001**
ABNORMAL	30 (22.3)	24(50)	1 (50)	
ADL SCORE				
<20	12 (9.0)	10(20.8)	1(50)	**0.028**
TIMED GET UP AND GO TEST				
>10 Sec	38(28.4)	27(56.2)	2(100)	**<0.001**
PHQ2				
>3	2(1.49)	1(2.08)	0	0.946

AGE AND SEX

Age of subjects did not correlate with their nutritional status refuting the belief that older people tend to be poorly nourished. Among the people who are Malnourished or are at risk of malnourishment, 50% were men and 50% women. There was no statistically significant variation based on sex.

SOCIOECONOMIC STATUS

Socioeconomic status was assessed using the Modified Kuppuswamy scale 2014. There was a statistically significant correlation between nutritional status and

socioeconomic situation; p=0.049. This reinforces the social belief that poorer sections of the society tends to be significantly undernourished.

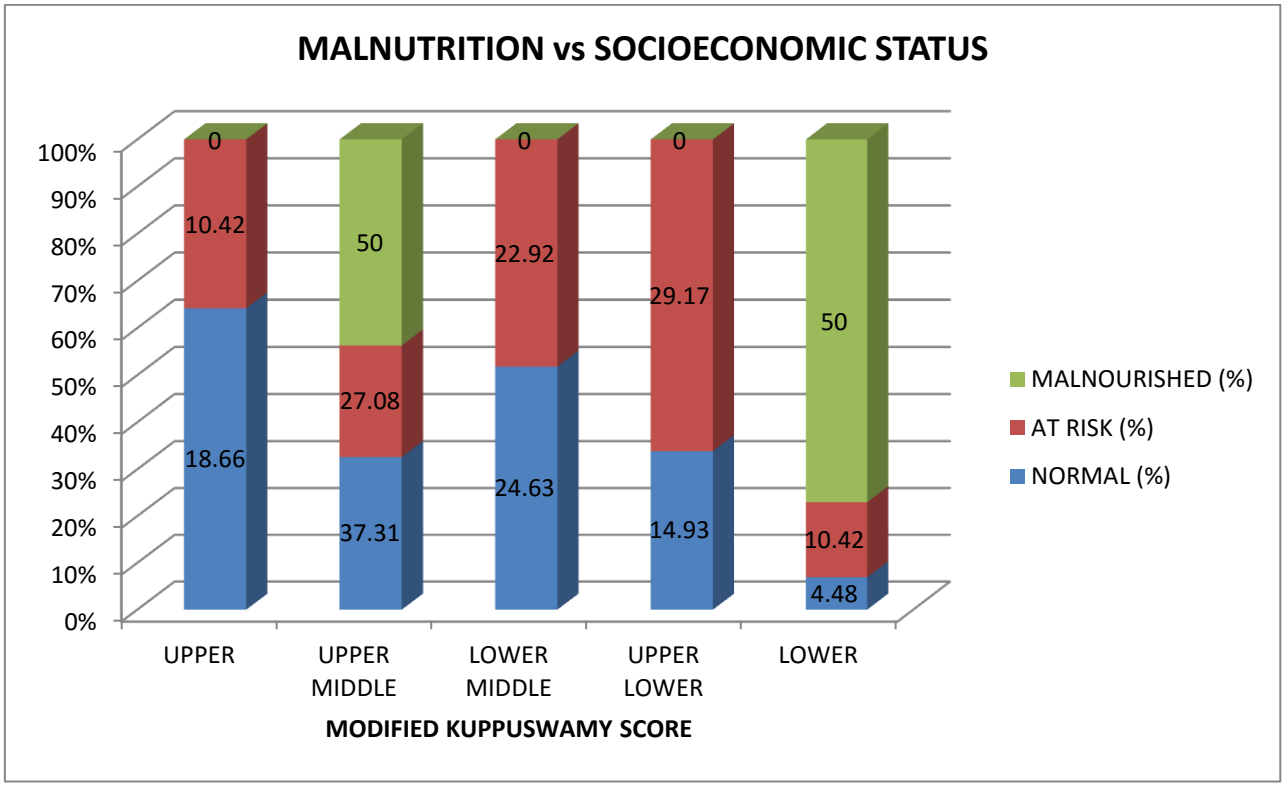


Figure 21 CORRELATION OF SOCIOECONOMIC STATUS AND FRAILTY

COMORBIDITIES

Several medical comorbidities including hypertension, diabetes mellitus (DM), ischemic heart disease (HIS), cerebrovascular accident (CVA), dyslipidaemia and COPD were evaluated in the study population. There was significant correlation between malnutrition and IHD with a p value of 0.046. Other diseases including " life-style" diseases like DM and dyslipidaemia were not significantly correlated with nutritional status in this study. Even the Charlson comorbidity score was found to be not significantly correlated to nutritional status.

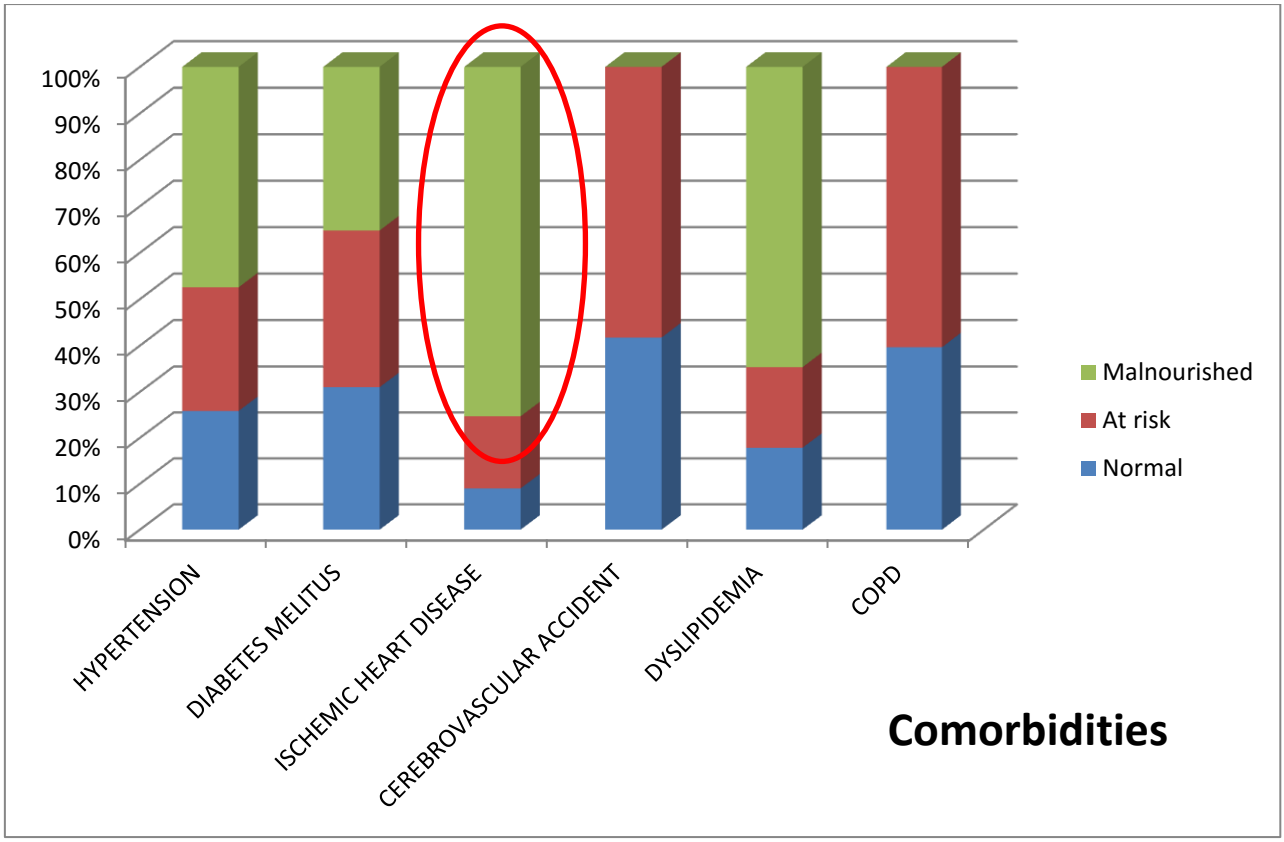


Figure 22 CORRELATION OF NUTRITIONAL STATUS WITH COMORBIDITIES

POLYPHARMACY

Polypharmacy is a significant problem for the elderly. But in this study the number of medications used or the presence of polypharmacy which is defined as >5 drugs being used regularly, is not found to be significantly affecting or affected by the nutritional status of the elderly.

COGNITIVE IMPAIRMENT

Mental status was evaluated using the Mini COG questionnaire. There was a very strong correlation between cognitive impairment and poor nutrition with a p value < 0.001. This could be attributed to the inability of a person with cognitive impairment to consume a nutritious diet and also the difficulty of care givers to feed

such a person. When an elderly person presents with cognitive impairment, diligent attention has to be directed at providing adequate nutrition also along with the rest of the management. The clock drawing test which is a part of the Mini COG, when assessed separately, was also found to be significantly correlated to nutritional status with a p value of 0.001. But a PHQ2 score >3 which indicates depression did not show any association with poor nutrition.

ACTIVITIES OF DAILY LIVING

Barthel's index was used to assess the activities of daily living. A lower score of <20 showed a significant association with malnutrition. Timed get up and got (TUG) test is used to assess a person's mobility and required good static and dynamic balance. A score of <10 seconds is considered normal. Subjects with time >10 seconds showed a strong correlation with poor nutritional status with a p value <0.001.

6.5 BASELINE CHARACTERISTICS ACCORDING TO FRAILTY

Table 17 BASELINE CHARACTERISTICS ACCORDING TO FRAILTY

DEMOGRAPHICS	NO FRAIL (n=3) No(%)	PREFRAIL (n=135) No(%)	FRAIL (n=47) No(%)	P VALUE
AGE				
60-69	3(100)	96(71.1)	20(42.6)	
70-79	0	29(21.5)	19(40.4)	**0.012**
80-89	0	10(7.4)	7(14.9)	
>/=90	0	0	1(2.1)	
SEX				
MALE	3(100)	96(71.1)	13(27.7)	**<0.0001**
FEMALE	0	39(28.9)	34(72.3)	
SOCIOECONOMIC STATUS				
UPPER	1(33. 3)	29 (21.5)	1(2.1)	
UPPER MIDDLE	1(33.3)	56(41.5)	7(14.9)	
LOWER MIDDLE	1(33.3)	28(20.7)	15(31.9)	
UPPER LOWER	0	17(12.6)	17(36.2)	**<0.0001**
LOWER	0	5(3.7)	7(14.9)	
COMORBIDITIES (present)				
HYPERTENSION (n=102)	0	72(53.3)	30(63.8)	0.070
DIABETES MELITUS (n=83)	1(33.3)	62(45.9)	20(42.6)	0.850
ISCHEMIC HEART DISEASE (n=14)	0	9(6.7)	5(10.6)	0.596
CEREBROVASCULAR ACCIDENT (n=3)	0	2(1.5)	1(2.1)	0.0932
DYSLIPIDEMIA (n=52)	1(33.3)	36(26.7)	15(31.9)	0.772
COPD (n=17)	0	11(8.2)	6(12.8)	0.549

POLYPHARMACY (present)	0	34(25.2)	13(27.7)	0.562
MINICOG				
COGNITIVE IMPAIREMENT	0	15(11.1)	11(23.4)	0.088
NORMAL	3(100)	120(88.9)	36(76.6)	
CLOCK DRAWING TEST				
NORMAL	3(100)	103(76.3)	34(51.1)	**0.003**
ABNORMAL	0	32(23.7)	23(48.9)	
ADL SCORE				
<20	0	13(9.6)	10(21.3)	0.092
TUG				
>10 sec	0	26(19.3)	41(87.2)	**<0.001**
PHQ2				
>3	0	2(1.5)	1(2.1)	0.932

Baseline characteristics were evaluated in relation to the frailty of the subject as assessed by the Fried Frailty Index.

AGE AND SEX

Advancing age definitely predisposes a person to frailty(p value 0.012) suggesting a strong association.

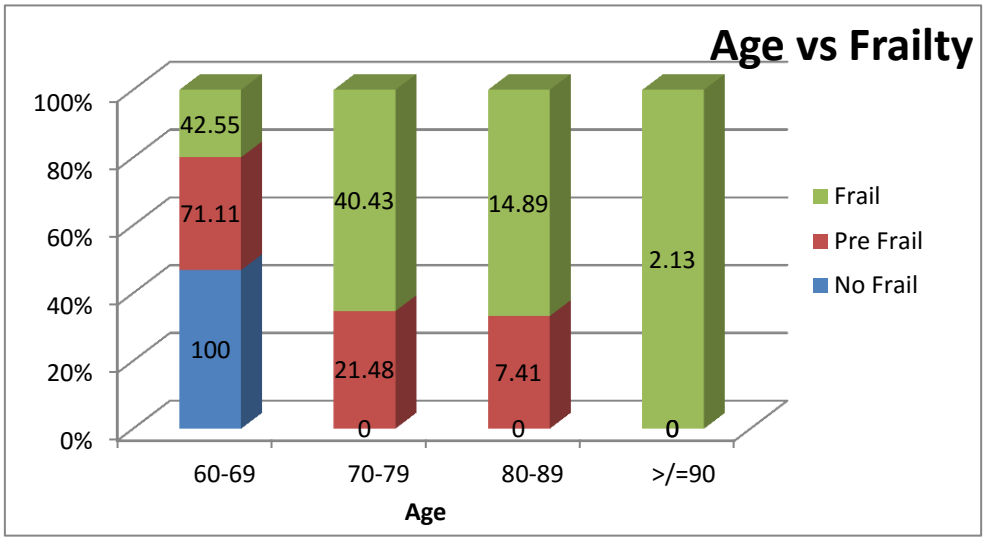


Figure 23 CORRELATION OF AGE AND FRAILTY

Frailty was significantly more in women than men with p value <0.001 suggesting a very strong correlation.

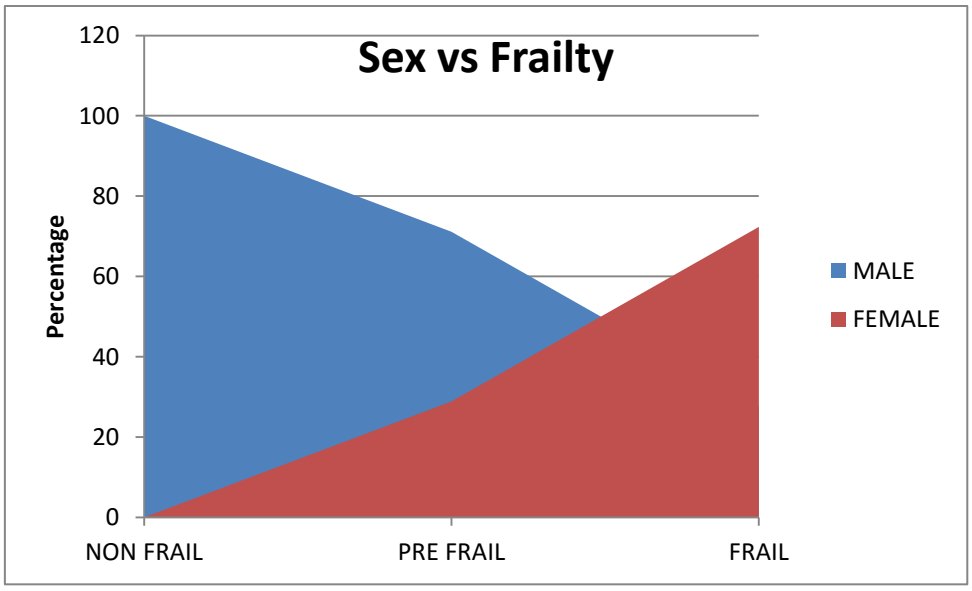


Figure 24 CORRELATION OF GENDER WITH FRAILTY

SOCIOECONIMIC STATUS

The modified Kuppuswamy scale 2014 showed a very strong correlation with frailty with a p value <0.001. This indicates that frailty is common among the poor sections of the society.

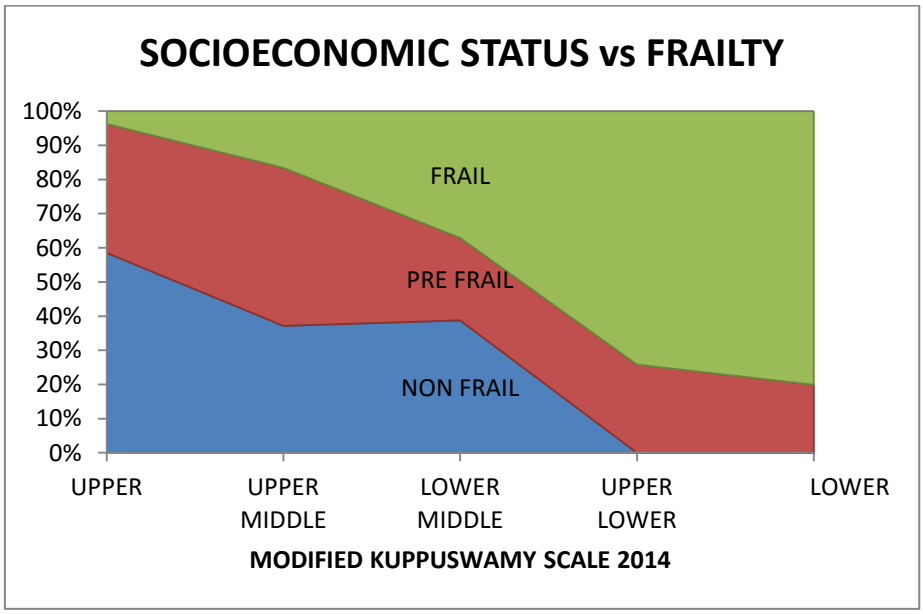


Figure 25 CORRELATION OF SOCIOECONOMIC STATUS AND FRAILTY

COMORBIDITIES AND POLYPHARMACY

Multiple comorbidities including hypertension, DM, IHD, CVA, dyslipidemia and COPD were evaluated in association with frailty. But none of them showed any significant association with frailty scores. Even the Charlson comorbidity index did not show any significant association with frailty.

The number of medications used by the subject or even polypharmacy which is the prescription of more than 5 regular drugs, did not show significant association with frailty.

COGNITIVE IMPAIRMENT

Cognitive assessment with Mini COG questionnaire did not reveal any significant correlation between cognitive impairment and frailty. But the clock drawing test, which is a part of the Mini COG tests, showed a significant correlation with a p value of 0.003. But depression as assessed by PHQ2 score > 3 did not correlate with frailty.

ACTIVITIES OF DAILY LIVING

Timed get up and go of > 10 seconds suggesting impaired mobility showed a very strong correlation with frailty with a p value <0.001. But the Barthel's ADL score <20 did not correlate with frailty. This is consistent with the fact that ageing causes loss of lean muscle mass and hence mobility. But this need not necessarily affect daily activities.

7 DISCUSSION

7.1 STUDY

This was a prospective observational study on the elderly (>/= 60 years) who presented to the Department of Geriatrics of a tertiary care centre in south India. Nutritional status of the study population was assessed using the Mini Nutritional Assessment tool and frailty using the Fried Frailty Scoring system.

7.2 STUDY POPULATION

A total of 185 subjects were recruited from the Geriatric out-patient clinic. 64% were in the 60-69year age group; 1 subject was 90 years of age. 60.54% were males. The average BMI of men was 23.20 and women was 24.15. More than 50% belonged to middle class socioeconomic status.

The commonest comorbidity was hypertension followed by diabetes mellitus and dyslipidemia. Polypharmacy which is the use of 4 or more regular drugs was present in 36.76% of the subjects. Mini COG test showed the presence of cognitive impairment in 14.05%. PHQ2 scores were more than 3 suggestive of depression in 1.6% but 14.05% were on antidepressant medications. The average Barthel's index for activities of daily living was 19.84. Timed get up and go test which assesses mobility and balance was more than 10 seconds in 36.22% of the subjects. The mean haemoglobin was 13.3g/dl in men and 11.9 g/dl in women. The average serum albumin for the study population was 4.31g/dl.

7.3 PREVALENCE OF MALNUTRITION

The prevalence of malnutrition in this study was 1.09% and that of at risk for malnutrition was 26.09%. Vedantam et al had reported the prevalence of malnutrition among rural elderly to be 14% and 49% for those at risk for malnutrition (28). Lahiri et al reported the prevalence of malnutrition and at risk for malnutrition in a community based study in West Bengal to be 29.4% and 60% respectively (27). This study has a lower prevalence of malnutrition in the study population than the other community based studies. We presume this is due to the population included in this study who are attending a tertiary care private hospital and hence are likely to have better health status.

7.4 FACTORS ASSOCIATED WITH MALNUTRITION

This study found association between socioeconomic status and malnutrition which is an expected link. The lower socioeconomic strata tend to be poorly nourished.

Presence of ischemic heart disease correlated with malnutrition. There was very strong association between cognitive impairment and clock drawing test with malnutrition. Daradkeh et al (112) showed association between cognitive impairment and malnutrition. Lyngroth et al(113)showed association between clock drawing test and nutritional risk. Cognitive impairment will reduce a person's ability to maintain a good dietary pattern. Clock drawing test is a simple tool which can be used in the outpatient clinic and even in the community and is easy to interpret. We reiterate the importance of this test along with cognitive assessment to

evaluate nutritional risk. Poor Barthel's score for activities of daily living and slower timed get and go test showed strong association with malnutrition. Villafañe etal (114)showed the association between Barthel's index and malnutrition. Malnutrition is an important and modifiable factor affecting activities of daily living and hence require proper attention.

7.5 PREVALENCE OF FRAILTY

The prevalence of frailty in this study was 25.54% and that for pre frailty was 72.83%. There is a paucity of large epidemiological studies on frailty in India. The other hospital based study from north India by Khandelwal etal using the same criteria has reported a prevalence of frailty as 33.2% (78). A recent multi nation study by Biritwim et al estimated this to be as high as 55.5% in India and 13.1% in China (115) . The SHARE study from Europe estimated the prevalence to be much lower with an average of 17% but as low as 5.8% in Switzerland(77). Developing countries like India need better Geriatric facilities to address the problem of frailty.

Handgrip strength, one criterion for frailty, was found to be weak in most of the patients, when western data was used as reference. This could explain the high prevalence of prefrailty and frailty in this study. It also suggests that, new criteria and standards are required for assessing frailty in our population.

7.6 FACTORS ASSOCIATED WITH FRAILTY

This study found age and female sex to be strongly associated with frailty. Fried etal (17) found strong association between age and female sex to frailty in his landmark study when she defined the criteria to evaluate frailty.

Socioeconomic score correlated with frailty suggesting that the poor are at higher risk of frailty. We also found strong association of clock drawing test and timed get up and go test with frailty. The former assesses cognitive function and the latter, mobility and balance. Clock drawing test is a simple tool and its usefulness in assessing frailty is a significant finding. Podsiadlo etal(116) defined the timed get up and go test as a basic test to assess frailty in the elderly. Frailty is associated with sarcopenia which can be the reason for a slower time in the timed get up and go test.

7.7 CORRELATION BETWEEN NUTRITIONAL ASSESSMENT AND FRAILTY

The study showed statistically significant correlation between nutritional assessment and frailty and vice versa. Frailty was seen to worsen with poorer nutritional status. And worsening frailty was seen to in turn deleteriously affect the nutritional status. Malnutrition and frailty are common entities in the elderly. Dorner etal showed that there is considerable overlap between under nutrition and frailty.(117) Kaiser etal emphasised the importance to improving the quality of nutrition including micronutrients to prevent frailty in the elderly(118). Malnutrition exaggerates the age associated loss of lean muscle mass which in turn

leads to frailty. Frailty decreases mobility and function thereby affecting the nutritional status.

7.8 CORRELATION BETWEEN INDIVIDUAL FACTORS OF NUTRITIONAL ASSESSMENT TO FRAILTY.

A significant outcome of this study was that several individual factors in the MNA and Fried frailty scoring systems showed significant correlation.

Anthropometric assessment parameters were significantly associated with frailty. Mid arm circumference less than 22cm and calf circumference less than 31cm were associated with worsening frailty. Bollwein etal (119)reported calf circumference to be significantly associated with frailty. Izawa etal showed significant association between falling BMI and mid arm circumference with activity decline in a longitudinal study(120)Wijnhoven et al showed strong association between mid-arm circumference and mortality(121). Mid arm circumference and calf circumference are easy parameters to assess in both hospital based and community based settings. They can be excellent screening tools to predict frailty and also to monitor the outcome of interventions including nutritional modifications.

General assessment parameters like dependent living, polypharmacy, acute stress, and neuropsychiatric illnesses were not found to be associated to frailty. This is in contradiction with some authors like Herr etal (122) who reported association between polypharmacy and frailty. Andrew etal (123) suggested to expect frailty in elderly with psychiatric illnesses. In this study, we have excluded subjects with any

acute illness and subjects with major illnesses who are more likely to have polypharmacy. This could be the reason for the lack of association between these factors and frailty in this study.

Factors in the dietary assessment including moderate to severe loss of appetite and low daily fluid intake of less than 5 cups showed significant association with frailty. Martone etal (124) showed that anorexia was strongly associated with frailty. Bollwein etal (119)proved the correlation of anorexia and reduced daily fluid intake to frailty. These provide easy and modifiable factors to improve frailty in the elderly which are simple to assess and implement. Feeding dependency is linked to emotional and socio-cultural factors. Inability to feed self maybe because of frailty but also can predispose to frailty. We found strong correlation between feeding dependency and frailty.

This study showed strong association between a person's self-assessment of nutritional and health status and presence of frailty. Bollwein et al (119) also showed a very strong similar association. This shows that the elderly are able to realise deterioration of their health status. This reinforces the need to take a patient's self-assessment into serious consideration. Care givers and sometimes health care workers may tend to give less importance to their self-assessment, tending to concentrate more on other measurable parameters. This finding is an eye-opener to the Geriatric care team.

7.9 CORRELATION BETWEEN INDIVIDUAL FACTORS OF FRAILTY TO NUTRITIONAL ASSESSMENT.

5% weight loss in the past 1 year, which is a criteria in the Fried frailty phenotype scoring was found to correlate well with malnutrition as expected.

Decreased gait speed characterised by taking more than 7 seconds to cover 15 feet and history of low physical activity were found to correlate strongly with malnutrition. There is sparse data correlating gait speed with nutritional status. Gait speed is a parameter in geriatric assessment and a screening tool for frailty. Studenski etal (125) showed correlation between gait speed and survival in the elderly. Low physical activity and gait speed can be attributed to age related lean loss of lean muscle mass and balance which are closely linked to nutritional status. When low gait speed or physical activity is detected, the geriatrician should be alert to use nutritional modification along with other management to correct this.

8 CONCLUSION

1. The prevalence of malnutrition and frailty among elderly are higher in the developing world. The prevalence of malnutrition in this study was 1.09% and that of at risk for malnutrition was 26.09%. The prevalence of frailty was 25.54% and that for pre frailty was 72.83% in this study..
2. Lower socioeconomic status, ischemic heart disease, cognitive impairment, abnormal clock drawing test, lower Barthel's ADL score and slower timed get up a go test are the factors which were significantly associated with malnutrition.
3. Age, female sex, lower socioeconomic status, abnormal clock drawing test and slower timed get up and go test correlate significantly with frailty.

4. Both frailty and malnutrition are strongly linked to each other and should be managed in concert with each other.
5. Simple assessments tools like mid arm circumference, calf circumference, loss of appetite and weight, feeding dependency, slower gait speed and physical activity and patient's self-health assessment are invaluable tools in evaluating frailty and malnutrition

9 LIMITATIONS

1. Sample size, though calculated based on published literature, could have been higher.
2. Exclusion of elderly with severe illnesses limits the extrapolation of these findings to that group.
3. As this study was conducted in a hospital setting on people who have robust health care seeking behavior, these findings cannot be extrapolated to a large number of elderly in the community who are neglected and/or abandoned.

10 REFERENCES

1. ElderlyinIndia_2016.pdf [Internet]. [cited 2016 Sep 17]. Available from: http://mospi.nic.in/mospi_new/upload/ElderlyinIndia_2016.pdf

2. untitled - global_health.pdf [Internet]. [cited 2016 Sep 17]. Available from: http://www.who.int/ageing/publications/global_health.pdf

3. Publications | Resources | HelpAge International [Internet]. [cited 2016 Sep 21]. Available from: http://www.helpage.org/resources/publications/

4. Macleod CC, Judge TG, Caird FI. Nutrition of the Elderly at Home I. Intakes of Energy, Protein, Carbohydrates and Fat. Age Ageing [Internet]. 1974 Aug 1 [cited 2016 Sep 21];3(3):158–66. Available from: http://ageing.oxfordjournals.org/content/3/3/158

5. C P, P T, C T, Mc C, O B, R G. Energy and nutrient intake of elderly hospitalized patients in a steady metabolic status versus catabolic status. J Nutr Health Aging [Internet]. 2003 2004 [cited 2016 Sep 21];8(6):518–20. Available from: http://europepmc.org/abstract/med/15543426

6. Gersovitz M, Motil K, Munro HN, Scrimshaw NS, Young VR. Human protein requirements: assessment of the adequacy of the current Recommended Dietary Allowance for dietary protein in elderly men and women. Am J Clin Nutr [Internet]. 1982 Jan 1 [cited 2016 Sep 21];35(1):6–14. Available from: http://ajcn.nutrition.org/content/35/1/6

7. Feskens EJ, Bowles CH, Kromhout D. Carbohydrate intake and body mass index in relation to the risk of glucose intolerance in an elderly population. Am J Clin Nutr [Internet]. 1991 Jul 1 [cited 2016 Sep 21];54(1):136–40. Available from: http://ajcn.nutrition.org/content/54/1/136

8. Kaplan RJ, Greenwood CE. Influence of dietary carbohydrates and glycaemic response on subjective appetite and food intake in healthy elderly persons. Int J Food Sci Nutr [Internet]. 2002 Jan 1 [cited 2016 Sep 21];53(4):305–16. Available from: http://dx.doi.org/10.1080/09637480220138160

9. Aging NI on. Vitamins & Minerals [Internet]. National Institute on Aging. 2013 [cited 2016 Sep 21]. Available from: https://www.nia.nih.gov/health/publication/whats-your-plate/vitamins-minerals

10. St-Onge M-P, Gallagher D. Body composition changes with aging: The cause or the result of alterations in metabolic rate and macronutrient oxidation? Nutr Burbank Los Angel Cty Calif [Internet]. 2010 Feb [cited 2016 Sep 21];26(2):152. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2880224/

11. Hughes VA, Frontera WR, Roubenoff R, Evans WJ, Singh MAF. Longitudinal changes in body composition in older men and women: role of body weight change and physical activity. Am J Clin Nutr. 2002 Aug;76(2):473–81.

12. Sallinen J, Stenholm S, Rantanen T, Heliöaara M, Sainio P, Koskinen S. Effect of age on the association between body fat percentage and maximal walking speed. J Nutr Health Aging. 2011 Jun;15(6):427–32.

13. Frontera WR, Hughes VA, Lutz KJ, Evans WJ. A cross-sectional study of muscle strength and mass in 45- to 78-yr-old men and women. J Appl Physiol Bethesda Md 1985. 1991 Aug;71(2):644–50.

14. Pirlich M, Lochs H. Nutrition in the elderly. Best Pract Res Clin Gastroenterol. 2001 Dec;15(6):869–84.

15. Effects of Aging on the Digestive System [Internet]. Merck Manuals Consumer Version. [cited 2016 Sep 21]. Available from: http://www.merckmanuals.com/home/digestive-disorders/biology-of-the-digestive-system/effects-of-aging-on-the-digestive-system

16. Chapter 89. Effect of Aging on Gastrointestinal Function | Hazzard's Geriatric Medicine and Gerontology, 6e | AccessMedicine | McGraw-Hill Medical [Internet]. [cited 2016 Sep 26]. Available from: http://accessmedicine.mhmedical.com/content.aspx?bookid=371&sectionid=41587707

17. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in Older Adults Evidence for a Phenotype. J Gerontol A Biol Sci Med Sci [Internet]. 2001 Mar 1 [cited 2016 Jul 28];56(3):M146–57. Available from: http://biomedgerontology.oxfordjournals.org/content/56/3/M146

18. Chapman IM. Endocrinology of anorexia of ageing. Best Pract Res Clin Endocrinol Metab. 2004 Sep;18(3):437–52.

19. Visvanathan R, Chapman IM. Undernutrition and Anorexia in the Older Person. Gastroenterol Clin North Am [Internet]. 2009 Sep [cited 2016 Sep 29];38(3):393–409. Available from: http://www.sciencedirect.com/science/article/pii/S088985530900065X

20. Morley JE. Anorexia of aging: physiologic and pathologic. Am J Clin Nutr. 1997 Oct;66(4):760–73.

21. Yeh S-S, Blackwood K, Schuster MW. The cytokine basis of cachexia and its treatment: are they ready for prime time? J Am Med Dir Assoc. 2008 May;9(4):219–36.

22. Turco R, Torpilliesi T, Bellelli G, Trabucchi M. Frequency of malnutrition in older adults: a comment. J Am Geriatr Soc. 2011 Apr;59(4):762–3.

23. Tsai AC, Chang JMC, Lin H, Chuang Y-L, Lin S-H, Lin Y-H. Assessment of the nutritional risk of >53-year-old men and women in Taiwan. Public Health Nutr. 2004 Feb;7(1):69–76.

24. Shahar S, Earland J, Suriah AR, Warnes AM. Social and health factors influencing poor nutritional status among rural elderly Malays. J Nutr Health Aging [Internet]. 2002 [cited 2016 Sep 24];6(6):363–9. Available from: https://ukm.pure.elsevier.com/en/publications/social-and-health-factors-influencing-poor-nutritional-status-amo

25. Meenu K, Amrit V, Gupta BP, Jasdeep S. Assessment Of Malnourishment In Elderly Of Rural Punjab. age [Internet]. 2014 [cited 2016 Jul 28];2:4. Available from: http://www.iapsmgc.org/index_pdf/156.pdf

26. Natarajan VS, RAVINDRAN S, KAILASH K, Krishnaswamy B, Suresh B, PRABHU P, et al. Assessment of nutrient intake and associated factors in an Indian elderly population. Age

Ageing [Internet]. 1993 [cited 2016 Jul 28];22(2):103–108. Available from: http://ageing.oxfordjournals.org/content/22/2/103.short

27. Lahiri S, Biswas A, Santra S, Lahiri S. Assessment of nutritional status among elderly population in a rural area of West Bengal, India. Int J Med Sci Public Health [Internet]. 2015 [cited 2016 Jul 28];1. Available from: http://www.scopemed.org/?mno=176188

28. Vedantam A, Subramanian V, Vijay Rao N, John K. Malnutrition in free-living elderly in rural south India: prevalence and risk factors. Public Health Nutr [Internet]. 2010 Sep [cited 2016 Jul 28];13(9):1328–32. Available from: http://www.journals.cambridge.org/abstract_S1368980009991674

29. Bauer JM, Wirth R, Troegner J, Erdmann J, Eberl T, Heppner HJ, et al. Ghrelin, anthropometry and nutritional assessment in geriatric hospital patients. Z Für Gerontol Geriatr [Internet]. 2007 Feb [cited 2016 Oct 1];40(1):31–6. Available from: http://link.springer.com/10.1007/s00391-007-0429-3

30. Charlton KE, Kolbe-Alexander TL, Nel JH. The MNA, but not the DETERMINE, screening tool is a valid indicator of nutritional status in elderly Africans. Nutr Burbank Los Angel Cty Calif. 2007 Aug;23(7–8):533–42.

31. Feldblum I, German L, Castel H, Harman-Boehm I, Bilenko N, Eisinger M, et al. Characteristics of undernourished older medical patients and the identification of predictors for undernutrition status. Nutr J [Internet]. 2007 [cited 2016 Oct 1];6:37. Available from: http://dx.doi.org/10.1186/1475-2891-6-37

32. Gil-Montoya JA, Subirá C, Ramón JM, González-Moles MA. Oral health-related quality of life and nutritional status. J Public Health Dent. 2008;68(2):88–93.

33. Kabir ZN, Ferdous T, Cederholm T, Khanam MA, Streatfied K, Wahlin A. Mini Nutritional Assessment of rural elderly people in Bangladesh: the impact of demographic, socio-economic and health factors. Public Health Nutr. 2006 Dec;9(8):968–74.

34. Norman K, Smoliner C, Valentini L, Lochs H, Pirlich M. Is bioelectrical impedance vector analysis of value in the elderly with malnutrition and impaired functionality? Nutr Burbank Los Angel Cty Calif. 2007 Aug;23(7–8):564–9.

35. Soini H, Routasalo P, Lauri S. Nutrition in patients receiving home care in Finland: tackling the multifactorial problem. J Gerontol Nurs. 2006 Apr;32(4):12–7.

36. Suominen MH, Kivisto SM, Pitkala KH. The effects of nutrition education on professionals' practice and on the nutrition of aged residents in dementia wards. Eur J Clin Nutr. 2007 Oct;61(10):1226–32.

37. Wikby K, Ek A-C, Christensson L. Nutritional status in elderly people admitted to community residential homes: comparisons between two cohorts. J Nutr Health Aging. 2006 Jun;10(3):232–8.

38. Asp EH. Factors affecting food decisions made by individual consumers. Food Policy [Internet]. 1999 May [cited 2016 Sep 21];24(2–3):287–94. Available from: http://www.sciencedirect.com/science/article/pii/S030691929900024X

39. Silverstein M, Cong Z, Li S. Intergenerational Transfers and Living Arrangements of Older People in Rural China: Consequences for Psychological Well-Being. J Gerontol B Psychol Sci Soc Sci [Internet]. 2006 Sep 1 [cited 2016 Sep 21];61(5):S256–66. Available from: http://psychsocgerontology.oxfordjournals.org/content/61/5/S256

40. Martins MCH, Fatigati FL, Véspoli TC, Martins LC, Pereira L a. A, Martins MA, et al. Influence of socioeconomic conditions on air pollution adverse health effects in elderly people: an analysis of six regions in São Paulo, Brazil. J Epidemiol Community Health [Internet]. 2004 Jan 1 [cited 2016 Sep 21];58(1):41–6. Available from: http://jech.bmj.com/content/58/1/41

41. Harris D, Haboubi N. Malnutrition screening in the elderly population. J R Soc Med [Internet]. 2005 Sep 1 [cited 2016 Sep 21];98(9):411–4. Available from: http://jrs.sagepub.com/content/98/9/411

42. Halford JC. Pharmacology of appetite suppression: implication for the treatment of obesity. Curr Drug Targets. 2001 Dec;2(4):353–70.

43. Donini LM, Savina C, Cannella C. Eating habits and appetite control in the elderly: the anorexia of aging. Int Psychogeriatr IPA. 2003 Mar;15(1):73–87.

44. Ackerman BH, Kasbekar N. Disturbances of Taste and Smell Induced by Drugs. Pharmacother J Hum Pharmacol Drug Ther [Internet]. 1997 May 6 [cited 2016 Oct 3];17(3):482–96. Available from: http://onlinelibrary.wiley.com/doi/10.1002/j.1875-9114.1997.tb03058.x/abstract

45. Chapman I, Parker B, Doran S, Feinle-Bisset C, Wishart J, Lush CW, et al. Low-dose pramlintide reduced food intake and meal duration in healthy, normal-weight subjects. Obes Silver Spring Md. 2007 May;15(5):1179–86.

46. Beck AM, Ovesen L, Osler M. The “Mini Nutritional Assessment” (MNA) and the “Determine Your Nutritional Health” Checklist (NSI Checklist) as predictors of morbidity and mortality in an elderly Danish population. Br J Nutr. 1999 Jan;81(1):31–6.

47. Sullivan DH, Patch GA, Walls RC, Lipschitz DA. Impact of nutrition status on morbidity and mortality in a select population of geriatric rehabilitation patients. Am J Clin Nutr. 1990 May;51(5):749–58.

48. Cederholm T, Jägrén C, Hellström K. Outcome of protein-energy malnutrition in elderly medical patients. Am J Med. 1995 Jan;98(1):67–74.

49. Dávalos A, Ricart W, Gonzalez-Huix F, Soler S, Marrugat J, Molins A, et al. Effect of malnutrition after acute stroke on clinical outcome. Stroke J Cereb Circ. 1996 Jun;27(6):1028–32.

50. Jensen JE, Jensen TG, Smith TK, Johnston DA, Dudrick SJ. Nutrition in orthopaedic surgery. J Bone Amp Jt Surg [Internet]. 1982 Dec 1;64(9):1263. Available from: http://jbjs.org/content/64/9/1263.abstract

51. Skipper A, Ferguson M, Thompson K, Castellanos VH, Porcari J. Nutrition Screening Tools An Analysis of the Evidence. J Parenter Enter Nutr [Internet]. 2012 May 1 [cited 2016 Sep 18];36(3):292–8. Available from: http://pen.sagepub.com/content/36/3/292

52. Wilson M-MG, Thomas DR, Rubenstein LZ, Chibnall JT, Anderson S, Baxi A, et al. Appetite assessment: simple appetite questionnaire predicts weight loss in community-dwelling adults and nursing home residents. Am J Clin Nutr. 2005 Nov;82(5):1074–81.

53. Keller HH, Goy R, Kane S-L. Validity and reliability of SCREEN II (Seniors in the community: risk evaluation for eating and nutrition, Version II). Eur J Clin Nutr. 2005 Oct;59(10):1149–57.

54. Stratton RJ, King CL, Stroud MA, Jackson AA, Elia M. "Malnutrition Universal Screening Tool" predicts mortality and length of hospital stay in acutely ill elderly. Br J Nutr. 2006 Feb;95(2):325–30.

55. Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. Nutr Burbank Los Angel Cty Calif. 1999 Jun;15(6):458–64.

56. Vellas B, Guigoz Y, Garry PJ, Nourhashemi F, Bennahum D, Lauque S, et al. The Mini Nutritional Assessment (MNA) and its use in grading the nutritional state of elderly patients. Nutrition [Internet]. 1999 [cited 2016 Jul 1];15(2):116–122. Available from: http://www.sciencedirect.com/science/article/pii/S0899900798001713

57. Vellas B, Guigoz Y, Baumgartner M, Garry PJ, Lauque S, Albarede JL. Relationships between nutritional markers and the mini-nutritional assessment in 155 older persons. J Am Geriatr Soc. 2000 Oct;48(10):1300–9.

58. Garry PJ, Wayne SJ, Vellas B. The New Mexico aging process study (1979-2003). A longitudinal study of nutrition, health and aging. J Nutr Health Aging. 2007 Apr;11(2):125–30.

59. Harris DG, Davies C, Ward H, Haboubi NY. An observational study of screening for malnutrition in elderly people living in sheltered accommodation. J Hum Nutr Diet Off J Br Diet Assoc. 2008 Feb;21(1):3-9-12.

60. Ferreira LS, Nascimento LFC, Marucci MFN. Use of the mini nutritional assessment tool in elderly people from long-term institutions of southeast of Brazil. J Nutr Health Aging. 2008 Mar;12(3):213–7.

61. Elkan A-C, Engvall I-L, Tengstrand B, Cederholm T, Hafström I. Malnutrition in women with rheumatoid arthritis is not revealed by clinical anthropometrical measurements or nutritional evaluation tools. Eur J Clin Nutr. 2008 Oct;62(10):1239–47.

62. Kuzuya M, Kanda S, Koike T, Suzuki Y, Satake S, Iguchi A. Evaluation of Mini-Nutritional Assessment for Japanese frail elderly. Nutr Burbank Los Angel Cty Calif. 2005 Apr;21(4):498–503.

63. Delacorte RR, Moriguti JC, Matos FD, Pfrimer K, Marchinil JS, Ferriolli E. Mini-nutritional assessment score and the risk for undernutrition in free-living older persons. J Nutr Health Aging. 2004;8(6):531–4.

64. Visvanathan R, Penhall R, Chapman I. Nutritional screening of older people in a sub-acute care facility in Australia and its relation to discharge outcomes. Age Ageing. 2004 May;33(3):260–5.

65. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: The Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev. 1996 Jan;54(1 Pt 2):S59-65.

66. Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci. 2001 Jun;56(6):M366-372.

67. Guigoz Y, Lauque S, Vellas BJ. Identifying the elderly at risk for malnutrition. Clin Geriatr Med [Internet]. 2002 [cited 2016 Jul 28];18(4):737–757. Available from: http://www.geriatric.theclinics.com/article/S0749-0690(02)00059-9/fulltext?refuid=S0002-8223(10)00639-5&refissn=0002-8223

68. Bell JJ, Pulle RC, Crouch AM, Kuys SS, Ferrier RL, Whitehouse SL. Impact of malnutrition on 12-month mortality following acute hip fracture. ANZ J Surg [Internet]. 2016 Mar 1 [cited 2016 Jul 28];86(3):157–61. Available from: http://onlinelibrary.wiley.com/doi/10.1111/ans.13429/abstract

69. Raynaud-Simon A, Revel-Delhom C, Hébuterne X. Clinical practice guidelines from the French health high authority: Nutritional support strategy in protein-energy malnutrition in the elderly. Clin Nutr [Internet]. [cited 2016 Oct 1];30(3):312–9. Available from: http://dx.doi.org/10.1016/j.clnu.2010.12.003

70. Rivière S, Gillette-Guyonnet S, Voisin T, Reynish E, Andrieu S, Lauque S, et al. A nutritional education program could prevent weight loss and slow cognitive decline in Alzheimer's disease. J Nutr Health Aging. 2001;5(4):295–9.

71. Gil Gregorio P, Ramirez Diaz SP, Ribera Casado JM, DEMENU group. Dementia and Nutrition. Intervention study in institutionalized patients with Alzheimer disease. J Nutr Health Aging. 2003;7(5):304–8.

72. Vellas B, Lauque S, Gillette-Guyonnet S, Andrieu S, Cortes F, Nourhashémi F, et al. Impact of nutritional status on the evolution of Alzheimer's disease and on response to acetylcholinesterase inhibitor treatment. J Nutr Health Aging. 2005;9(2):75–80.

73. Brocklehurst JC, Robertson D, James-Groom P. Skeletal deformities in the elderly and their effect on postural sway. J Am Geriatr Soc. 1982 Aug;30(8):534–8.

74. Morley JE, Vellas B, van Kan GA, Anker SD, Bauer JM, Bernabei R, et al. Frailty consensus: a call to action. J Am Med Dir Assoc. 2013 Jun;14(6):392–7.

75. Fugate Woods N, LaCroix AZ, Gray SL, Aragaki A, Cochrane BB, Brunner RL, et al. Frailty: Emergence and Consequences in Women Aged 65 and Older in the Women's Health Initiative Observational Study. J Am Geriatr Soc [Internet]. 2005 Aug 1 [cited 2016 Jul 28];53(8):1321–30. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.1532-5415.2005.53405.x/abstract

76. Cawthon PM, Marshall LM, Michael Y, Dam T-T, Ensrud KE, Barrett-Connor E, et al. Frailty in Older Men: Prevalence, Progression, and Relationship with Mortality. J Am Geriatr Soc [Internet]. 2007 Aug 1 [cited 2016 Jul 28];55(8):1216–23. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.1532-5415.2007.01259.x/abstract

77. Börsch-Supan A, Brandt M, Hunkler C, Kneip T, Korbmacher J, Malter F, et al. Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE). Int J Epidemiol [Internet]. 2013 Aug [cited 2016 Jul 28];42(4):992–1001. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3780997/

78. Khandelwal D, Goel A, Kumar U, Gulati V, Narang R, Dey AB. Frailty is associated with longer hospital stay and increased mortality in hospitalized older patients. J Nutr Health Aging [Internet]. 2012 [cited 2016 Jul 28];16(8):732–735. Available from: http://link.springer.com/article/10.1007/s12603-012-0369-5

79. Biritwum RB, Minicuci N, Yawson AE, Theou O, Mensah GP, Naidoo N, et al. Prevalence of and factors associated with frailty and disability in older adults from China, Ghana, India, Mexico, Russia and South Africa. Maturitas. 2016 Sep;91:8–18.

80. Cappola AR, Xue Q-L, Ferrucci L, Guralnik JM, Volpato S, Fried LP. Insulin-like growth factor I and interleukin-6 contribute synergistically to disability and mortality in older women. J Clin Endocrinol Metab. 2003 May;88(5):2019–25.

81. Walston J, McBurnie MA, Newman A, Tracy RP, Kop WJ, Hirsch CH, et al. Frailty and activation of the inflammation and coagulation systems with and without clinical comorbidities: results from the Cardiovascular Health Study. Arch Intern Med. 2002 Nov 11;162(20):2333–41.

82. Yao X, Hamilton RG, Weng N, Xue Q-L, Bream JH, Li H, et al. Frailty is associated with impairment of vaccine-induced antibody response and increase in post-vaccination influenza infection in community-dwelling older adults. Vaccine. 2011 Jul 12;29(31):5015–21.

83. Rockwood K, Mitnitski A, Song X, Steen B, Skoog I. Long-term risks of death and institutionalization of elderly people in relation to deficit accumulation at age 70. J Am Geriatr Soc. 2006 Jun;54(6):975–9.

84. Sternberg SA, Wershof Schwartz A, Karunananthan S, Bergman H, Mark Clarfield A. The identification of frailty: a systematic literature review. J Am Geriatr Soc. 2011 Nov;59(11):2129–38.

85. Leong DP, Teo KK, Rangarajan S, Lopez-Jaramillo P, Avezum A, Orlandini A, et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. Lancet Lond Engl. 2015 Jul 18;386(9990):266–73.

86. Chiarantini D, Volpato S, Sioulis F, Bartalucci F, Del Bianco L, Mangani I, et al. Lower extremity performance measures predict long-term prognosis in older patients hospitalized for heart failure. J Card Fail. 2010 May;16(5):390–5.

87. Woo J, Yu R, Wong M, Yeung F, Wong M, Lum C. Frailty Screening in the Community Using the FRAIL Scale. J Am Med Dir Assoc. 2015 May 1;16(5):412–9.

88. Ensrud KE, Ewing SK, Taylor BC, Fink HA, Cawthon PM, Stone KL, et al. Comparison of 2 frailty indexes for prediction of falls, disability, fractures, and death in older women. Arch Intern Med. 2008 Feb 25;168(4):382–9.

89. Home [Internet]. [cited 2016 Oct 2]. Available from: http://www.bgs.org.uk/

90. Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. J Gerontol A Biol Sci Med Sci. 2007 Jul;62(7):722–7.

91. Theou O, Brothers TD, Mitnitski A, Rockwood K. Operationalization of frailty using eight commonly used scales and comparison of their ability to predict all-cause mortality. J Am Geriatr Soc. 2013 Sep;61(9):1537–51.

92. Makary MA, Segev DL, Pronovost PJ, Syin D, Bandeen-Roche K, Patel P, et al. Frailty as a Predictor of Surgical Outcomes in Older Patients. J Am Coll Surg [Internet]. 2010 Jun [cited 2016 Aug 1];210(6):901–8. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1072751510000591

93. Baldwin C, Parsons T, Logan S. Dietary advice for illness-related malnutrition in adults. Cochrane Database Syst Rev. 2007;(1):CD002008.

94. Bauer J, Biolo G, Cederholm T, Cesari M, Cruz-Jentoft AJ, Morley JE, et al. Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group. J Am Med Dir Assoc. 2013 Aug;14(8):542–59.

95. Kim C-O, Lee K-R. Preventive effect of protein-energy supplementation on the functional decline of frail older adults with low socioeconomic status: a community-based randomized controlled study. J Gerontol A Biol Sci Med Sci. 2013 Mar;68(3):309–16.

96. Wong YYE, McCaul KA, Yeap BB, Hankey GJ, Flicker L. Low vitamin D status is an independent predictor of increased frailty and all-cause mortality in older men: the Health in Men Study. J Clin Endocrinol Metab. 2013 Sep;98(9):3821–8.

97. Pabst G, Zimmermann A-K, Huth C, Koenig W, Ludwig T, Zierer A, et al. Association of low 25-hydroxyvitamin D levels with the frailty syndrome in an aged population: Results from the KORA-Age Augsburg study. J Nutr Health Aging [Internet]. 2014 Nov 21 [cited 2016 Oct 3];19(3):258–64. Available from: http://link.springer.com/article/10.1007/s12603-014-0546-9

98. Vogt S, Decke S, de Las Heras Gala T, Linkohr B, Koenig W, Ladwig K-H, et al. Prospective association of vitamin D with frailty status and all-cause mortality in older adults: Results from the KORA-Age Study. Prev Med. 2015 Apr;73:40–6.

99. Kojima G, Tanabe M. Frailty is Highly Prevalent and Associated with Vitamin D Deficiency in Male Nursing Home Residents. J Am Geriatr Soc. 2016 Sep;64(9):e33-35.

100. Cherniack EP, Florez HJ, Troen BR. Emerging therapies to treat frailty syndrome in the elderly. Altern Med Rev J Clin Ther. 2007 Sep;12(3):246–58.

101. Semba RD, Blaum C, Guralnik JM, Moncrief DT, Ricks MO, Fried LP. Carotenoid and vitamin E status are associated with indicators of sarcopenia among older women living in the community. Aging Clin Exp Res. 2003 Dec;15(6):482–7.

102. Physical therapy treatment on frailty syndrome: systematic review [Internet]. [cited 2016 Oct 2]. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-35552009000500002&lng=en&nrm=iso&tlng=en

103. Giné-Garriga M, Roqué-Fíguls M, Coll-Planas L, Sitjà-Rabert M, Salvà A. Physical exercise interventions for improving performance-based measures of physical function in

community-dwelling, frail older adults: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2014 Apr;95(4):753–769.e3.

104. Paw MJMCA, A C, Uffelen JGZ van, Riphagen I, Mechelen W van. The Functional Effects of Physical Exercise Training in Frail Older People. Sports Med [Internet]. 2012 Oct 7 [cited 2016 Oct 3];38(9):781–93. Available from: http://link.springer.com/article/10.2165/00007256-200838090-00006

105. Pascual López A, Roqué i Figuls M, Urrútia Cuchi G, Berenstein EG, Almenar Pasies B, Balcells Alegre M, et al. Systematic review of megestrol acetate in the treatment of anorexia-cachexia syndrome. J Pain Symptom Manage. 2004 Apr;27(4):360–9.

106. Jürschik P, Nunin C, Botigué T, Escobar MA, Lavedán A, Viladrosa M. Prevalence of frailty and factors associated with frailty in the elderly population of Lleida, Spain: The FRALLE survey. Arch Gerontol Geriatr [Internet]. 2012 Nov [cited 2016 Aug 1];55(3):625–31. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0167494312001446

107. Semba RD, Bartali B, Zhou J, Blaum C, Ko C-W, Fried LP. Low serum micronutrient concentrations predict frailty among older women living in the community. J Gerontol A Biol Sci Med Sci. 2006 Jun;61(6):594–9.

108. Giné-Garriga M, Roqué-Fíguls M, Coll-Planas L, Sitjà-Rabert M, Salvà A. Physical Exercise Interventions for Improving Performance-Based Measures of Physical Function in Community-Dwelling, Frail Older Adults: A Systematic Review and Meta-Analysis. Arch Phys Med Rehabil [Internet]. 2014 Apr [cited 2016 Aug 1];95(4):753–769.e3. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0003999313012136

109. Tsai AC, Chang JM, Lin H, Chuang Y-L, Lin S-H, Lin Y-H. Assessment of the nutritional risk of > 53-year-old men and women in Taiwan. Public Health Nutr [Internet]. 2004 Feb [cited 2016 Jul 28];7(1). Available from: http://www.journals.cambridge.org/abstract_S1368980004000114

110. Vellas B, Villars H, Abellan G, Soto ME, Rolland Y, Guigoz Y, et al. Overview of the MNA--Its history and challenges. J Nutr Health Aging. 2006 Dec;10(6):456-463-465.

111. Ferner RE, Aronson JK. Communicating information about drug safety. BMJ. 2006 Jul 15;333(7559):143–5.

112. Daradkeh G, Essa MM, Al-Adawi SS, Koshy RP, Al-Asmi A, Waly MI. Nutritional status and cognitive impairment in elderly. Pak J Biol Sci PJBS. 2014 Oct;17(10):1098–105.

113. Lyngroth AL, Hernes SMS, Madsen B-O, Söderhamn U, Grov EK. Nutritional screening of patients at a memory clinic--association between patients' and their relatives' self-reports. J Clin Nurs. 2016 Mar;25(5–6):760–8.

114. Villafañe JH, Pirali C, Dughi S, Testa A, Manno S, Bishop MD, et al. Association between malnutrition and Barthel Index in a cohort of hospitalized older adults article information. J Phys Ther Sci [Internet]. 2016 Feb [cited 2016 Sep 25];28(2):607–12. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4793019/

115. Biritwum RB, Minicuci N, Yawson AE, Theou O, Mensah GP, Naidoo N, et al. Prevalence of and factors associated with frailty and disability in older adults from China, Ghana, India, Mexico, Russia and South Africa. Maturitas. 2016 Sep;91:8–18.

116. Podsiadlo D, Richardson S. The timed “Up & Go”: a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991 Feb;39(2):142–8.

117. Dorner TE, Luger E, Tschinderle J, Stein KV, Haider S, Kapan A, et al. Association between nutritional status (MNA®-SF) and frailty (SHARE-FI) in acute hospitalised elderly patients. J Nutr Health Aging. 2014 Mar;18(3):264–9.

118. Kaiser M, Bandinelli S, Lunenfeld B. Frailty and the role of nutrition in older people. A review of the current literature. Acta Bio-Medica Atenei Parm. 2010;81 Suppl 1:37–45.

119. Bollwein J, Volkert D, Diekmann R, Kaiser MJ, Uter W, Vidal K, et al. Nutritional status according to the Mini Nutritional Assessment (MNA®) and frailty in community dwelling older persons: A close relationship. J Nutr Health Aging [Internet]. 2013 [cited 2016 Sep 21];4(17):351–6. Available from: https://www.infona.pl//resource/bwmeta1.element.springer-df9c5a64-0d78-35a1-8747-33d62f94020a

120. Izawa S, Enoki H, Hirakawa Y, Iwata M, Hasegawa J, Iguchi A, et al. The longitudinal change in anthropometric measurements and the association with physical function decline in Japanese community-dwelling frail elderly. Br J Nutr. 2010 Jan;103(2):289–94.

121. Wijnhoven HAH, van Bokhorst-de van der Schueren MAE, Heymans MW, de Vet HCW, Kruizenga HM, Twisk JW, et al. Low Mid-Upper Arm Circumference, Calf Circumference, and Body Mass Index and Mortality in Older Persons. J Gerontol A Biol Sci Med Sci [Internet]. 2010 Oct 1 [cited 2016 Sep 25];65A(10):1107–14. Available from: http://biomedgerontology.oxfordjournals.org/cgi/doi/10.1093/gerona/glq100

122. Herr M, Robine J-M, Pinot J, Arvieu J-J, Ankri J. Polypharmacy and frailty: prevalence, relationship, and impact on mortality in a French sample of 2350 old people. Pharmacoepidemiol Drug Saf. 2015 Jun;24(6):637–46.

123. Andrew MK, Rockwood K. Psychiatric illness in relation to frailty in community-dwelling elderly people without dementia: a report from the Canadian Study of Health and Aging. Can J Aging Rev Can Vieil. 2007;26(1):33–8.

124. Martone A, Onder G, Vetrano D, Ortolani E, Tosato M, Marzetti E, et al. Anorexia of Aging: A Modifiable Risk Factor for Frailty. Nutrients [Internet]. 2013 Oct 14 [cited 2016 Sep 25];5(10):4126–33. Available from: http://www.mdpi.com/2072-6643/5/10/4126/

125. Studenski S, Perera S, Patel K, et al. GAit speed and survival in older adults. JAMA [Internet]. 2011 Jan 5 [cited 2016 Sep 25];305(1):50–8. Available from: http://dx.doi.org/10.1001/jama.2010.1923

11 ANNEXURE

11.1 MININUTRITINAL ASSESSMENT

Last name: First name: Sex: Date:

Age: Weight, kg: Height, cm: I.D. Number:

Complete the screen by filling in the boxes with the appropriate numbers.
Add the numbers for the screen. If score is 11 or less, continue with the assessment to gain a Malnutrition Indicator Score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe loss of appetite
1 = moderate loss of appetite
2 = no loss of appetite ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed/chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F Body Mass Index (BMI) (weight in kg) / (height in m)²
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

Screening score (subtotal max. 14 points) ☐☐
12 points or greater Normal – not at risk – no need to complete assessment
11 points or below Possible malnutrition – continue assessment

Assessment

G Lives independently (not in a nursing home or hospital)
0 = no 1 = yes ☐

H Takes more than 3 prescription drugs per day
0 = yes 1 = no ☐

I Pressure sores or skin ulcers
0 = yes 1 = no ☐

J How many full meals does the patient eat daily?
0 = 1 meal
1 = 2 meals
2 = 3 meals ☐

K Selected consumption markers for protein intake
- At least one serving of dairy products (milk, cheese, yogurt) per day? yes ☐ no ☐
- Two or more servings of legumes or eggs per week? yes ☐ no ☐
- Meat, fish or poultry every day yes ☐ no ☐

0.0 = if 0 or 1 yes
0.5 = if 2 yes
1.0 = if 3 yes ☐.☐

L Consumes two or more servings of fruits or vegetables per day?
0 = no 1 = yes ☐

M How much fluid (water, juice, coffee, tea, milk...) is consumed per day?
0.0 = less than 3 cups
0.5 = 3 to 5 cups
1.0 = more than 5 cups ☐.☐

N Mode of feeding
0 = unable to eat without assistance
1 = self-fed with some difficulty
2 = self-fed without any problem ☐

O Self view of nutritional status
0 = views self as being malnourished
1 = is uncertain of nutritional state
2 = views self as having no nutritional problem ☐

P In comparison with other people of the same age, how does the patient consider his/her health status?
0.0 = not as good
0.5 = does not know
1.0 = as good
2.0 = better ☐.☐

Q Mid-arm circumference (MAC) in cm
0.0 = MAC less than 21
0.5 = MAC 21 to 22
1.0 = MAC 22 or greater ☐.☐

R Calf circumference (CC) in cm
0 = CC less than 31 1 = CC 31 or greater ☐

Assessment (max. 16 points) ☐☐.☐
Screening score ☐☐
Total Assessment (max. 30 points) ☐☐.☐

Malnutrition Indicator Score
17 to 23.5 points at risk of malnutrition ☐
Less than 17 points malnourished ☐

Ref.: Guigoz Y, Vellas B and Garry P.J. 1994. Mini Nutritional Assessment: A practical assessment tool for grading the nutritional state of elderly patients. *Facts and Research in Gerontology.* Supplement #2:15-59.
Rubenstein LZ, Harker J, Guigoz Y and Vellas B. Comprehensive Geriatric Assessment (CGA) and the MNA: An Overview of CGA, Nutritional Assessment, and Development of a Shortened Version of the MNA. In: "Mini Nutritional Assessment (MNA): Research and Practice in the Elderly". Vellas B, Garry P.J and Guigoz Y., editors. Nestlé Nutrition Workshop Series. Clinical & Performance Programme, vol. 1. Karger, Bâle, in press.

11.2 MID ARM CIRCUMFERENCE

1. Ask the patient to bend their non-dominant arm at the elbow at a right angle with the palm up.

2. Measure the distance between the acromial surface of the scapula (bony protrusion surface of upper shoulder) and the olecranon process of the elbow (bony point of the elbow) on the back of the arm..

3. Mark the mid-point between the two with the pen..

4. Ask the patient to let the arm hang loosely by his/her side.

5. Position the tape at the mid-point on the upper arm and tighten snugly. Avoid pinching or causing indentation..

6. Record measurement in cm.

7. If MAC is less than 21, score = 0.
   If MAC is 21-22, score = 0.5.
   If MAC is 22 or greater, score = 1.0

11.3 CALF CIRCUMFERENCE

1. The subject should be sitting with the left leg hanging loosely or standing with their weight evenly distributed on both feet.

2. Ask the patient to roll up the trouser leg to uncover to calf.

3. Wrap the tape around the calf at the widest part and note the measurement.

4. Take additional measurements above and below the point to ensure that the first measurement was the largest.

5. An accurate measurement can only be obtained if the tape is at a right angle to the length of the calf, and should be recorded to the nearest 0.1 cm

11.4 HAND GRIP STRENGTH USING JAMAR HAND DYNAMOMETER

HAND GRIP

Grip strength: JAMAR Hand Dynamometer

- The JAMAR Adjustable Hand Dynamometer offers many features for both routine screening work and for evaluating hand trauma and disease.
- To assess the grip strength of the dominant hand.

Description:

- The JAMAR displays grip force in pounds and kilograms—200 pounds or 90 kilograms maximum reading.

Proceedure:

- Position: Seated, shoulder adducted and neutrally rotated, elbow flexed at 90º, forearm in neutral position, and wrist between 0º and 30º dorsiflexion and between 0º and 15º ulnar deviation.
- 3 trials provided with 2-minute break.
- The final score will be taken the average of 3 trials

Benefits:

- Accurate and Reproducible.
- The JAMAR is isometric in use, regardless of grip strength. The hand grasp is both comfortable and effective. These features combine to ensure accurate, and reproducible results.

Table 18 Normative data in the elderly for hand held dynamometer

Gender	60 – 64Yrs (Pounds/Kgs)	65 – 69Yrs (Pounds/Kgs)	70 – 75Yrs (Pounds/Kgs)	75+Yrs (Pounds/Kgs)
Right **Hand**	*Male - 89.7/40.7* Female - 55.1/25	*Male - 91.9/41.7* Female - 45.6/20.7	*Male - 79.3/36* Female - 49.6/22.5	*Male - 65.7/29.8* Female - 42.6/19.3
Left **Hand**	*Male – 76.8/34.9* Female - 45.7/20.72	*Male - 76.8/34.8* Female - 41.0/18.6	*Male – 64.8/29.3* Female - 41.1/18.6	*Male - 55.0/25* Female - 37.6/17

Reference : Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S, et al. Grip and pinch strength: normative data for adults. Arch Phys Med Rehabil. 1985;66(2):69–74

WEAK HAND GRIP:

Hand grip is considered weak when the final score is below the normative data

11.5 GAIT SPEED

Test Protocol: Measure and mark a standard distance, e.g. 15feet

Then measure and mark 5 feet before the start and 5 feet after the end.

Put cones at the starting line and the finish line.

5 feet	15 feet	5 feet
← Starting line	← begin timing stop timing →	Finish line →

Instructions: “Walk at a comfortable pace”.

Participant’s performance: _____ seconds

Calculated gait speed: _____ feet/sec

SLOW WALKING SPEED >6-7 FEET/SEC

11.6 EXHAUSTION

CES-D questionnaire; Patient is asked 2 questions:

How often in the past week did you feel like everything you did was an effort?/like you could not get going? (often [i.e., 3 days] or not often [i.e., 0–2 days])

Positive if often is the answer to either question

11.7 THE MINNESOTA LEISURE TIME PHYSICAL ACTIVITY QUESTIONNAIRE

TABLE I ACTIVITIES AND INTENSITY CODES

Code	Activity	Intensity code	Code	Activity	Intensity code
010	Walking for pleasure	3.5	440	Softball	5.0
015	Walking to and from work	4.0	450	Badminton	7.0
020	Walking during work break	3.5	460	Paddle ball	6.0
030	Using stairs when elevator is available	8.0	470	Racket ball	7.0
			480	Basketball; non-game	6.0
040	Cross-country hiking	6.0	490	Basketball; game play	8.0
050	Back packing	7.0	500	Basketball; officiating	7.0
060	Mountain climbing	8.0	510	Touch football	8.0
115	Bicycling to work and/or for pleasure	4.0	520	Handball	12.0
			530	Squash	12.0
125	Dancing—Ballroom and/or square	5.5	540	Soccer	7.0
			070	Golf: riding a power cart	3.5
150	Home exercise	4.5	080	Golf: walking, pulling clubs on cart	5.0
160	Health club	6.0			
180	Jogging and walking	6.0	090	Golf: walking and carrying clubs	5.5
200	Running	8.0			
210	Weight lifting	3.0	550	Mowing lawn with riding mower	2.5
220	Water skiing	6.0			
235	Sailing	3.0	560	Mowing lawn walking behind power mower	4.5
250	Canoeing or rowing for pleasure	3.5	570	Mowing lawn pushing hand mower	6.0
260	Canoeing or rowing in competition	12.0	580	Weeding and cultivating garden	4.5
270	Canoeing on a camping trip	4.0	590	Spading, digging, filling in garden	5.0
280	Swimming (at least 50 ft) at a pool	6.0	600	Raking lawn	4.0
			610	Snow shoveling by hand	6.0
295	Swimming at the beach	6.0	620	Carpentry in workshop	3.0
310	Scuba diving	7.0	630	Painting inside of house, includes paper hanging	4.5
320	Snorkeling	5.0			
340	Snow skiing, downhill	7.0	640	Carpentry outside	6.0
350	Snow skiing, cross country	8.0	650	Painting outside of house	5.0
			660	Fishing from river bank	3.5
360	Ice (or roller) skating	7.0	670	Fishing in stream with wading boots	6.0
370	Sledging or tobogganing	7.0			
390	Bowling	3.0	680	Hunting pheasants or grouse	6.0
400	Volley ball	4.0	690	Hunting rabbits, prairie chickens, squirrels, raccoon	5.0
410	Table tennis	4.0			
420	Tennis, singles	8.0	710	Hunting large game: deer, elk, bear	6.0
430	Tennis, doubles	6.0			

Energy expended in a specific activity is estimated as the product of the intensity code I and the duration of exercise in minutes for a year . The intensity value multiplied by time (in minutes) gives kilocalories expended over stated time

Activity Metabolic Index (AMI) is designated for any given activity: AMI = I x D.

PHYSICAL ACTIVITY

Subjects were interviewed regarding their physical activity, it duration in minutes and number of days for the past 1 week. Energy expenditure was calculated in Kcal using the above mentioned formula.

LOW PHYSICAL ACTIVITY

Kcals spent per week: males expending <383 Kcals and females <270 Kcal

11.8 KUPPUSWAMY SOCIOECONOMIC SCALE

Kuppuswamy socioeconomic scale (Urban, 1976)(1)

	Score
Education	
Profession or honours	7
Graduate or post graduate	6
Intermediate or post high school diploma	5
High school certificate	4
Middle school certificate	3
Primary school certificate	2
Illiterate	1
Occupation	
Profession	10
Semi-profession	6
Clerical, shop-owner, farmer	5
Skilled worker	4
Semi-skilled worker	3
Unskilled worker	2
Unemployed	1

Family income (Rs.) per month in the original and modified Kuppuswamy scale#

Years			
1976	1998	2007	2012 (June) (current price index[4])
≥2000	≥13,408	≥19,844	≥31,507
1000-1999	6704-13,407	9922-19,843	15,754-31,506
750-999	5028-6703	7441-9921	11,817-15,753
500-749	3352-5027	4961-7440	7878-11,816
300-499	2011-3351	2976-4960	4727-7877
101-299	677-2010	1002-2975	1590-4726
≤100	≤676	≤1001	≤1589

#First, second, and third column of the table were adapted from references 1, 2, and 5 respectively

Family income per month (in Rs.)	
≥2000	12
1000-1999	10
750-999	6
500-749	4
300-499	3
101-299	2
≤100	1
Socioeconomic class	
Upper	26-29
Upper middle	16-25
Lower middle	11-15
Upper lower	5-10
Lower	0<5

11.9 CHARLSON COMORBIDITY INDEX

Charlson Comorbidity Index
Scoring

Condition	Variable name	Points	Notes
Myocardial infarction	MI	1	
Congestive heart failure	CHF	1	
Peripheral vascular disease or bypass	PVD	1	
Cerebrovascular disease or transient ischemic disease	CVA	1	CVA only
Hemiplegia	PLEGIA	2	If hemiplegia, do not count CVA separately
Pulmonary disease/ asthma	COPD	1	
Diabetes	DM	1	DM only
Diabetes with end organ damage	DMENDORGAN	2	If end organ damage, do not count DM separately
Renal disease	RENAL	2	
Mild liver disease	MILDLIVER	2	
Severe liver disease	SEVERELIVER	3	
Gastric or peptic ulcer	ULCER	1	
Cancer (lymphoma, leukemia, solid tumor)	CANCER	2	Nonmetastatic cancer only
Metastatic solid tumor	METASTASES	6	If Metastatic, do not count cancer separately
Dementia or Alzheimer's	DEMENTIA	1	
Rheumatic or connective tissue disease	RHEUMATIC	1	
HIV or AIDS	HIV	6	
Hypertension	HBP	1	
Skin ulcers/ cellulitis	SKIN ULCER	2	
Depression	DEPRESSION	1	
Warfarin	WARFARIN	1	

1)LOW - 0

2)MEDIUM – 1-2

3)HIGH – 3-4

4)VERY HIGH >5

11.10 MINI COG TEST

Instructions

ADMINISTRATION	SPECIAL INSTRUCTIONS
1. Get patient's attention and ask him or her to remember three unrelated words. Ask patient to repeat the words to ensure the learning was correct	• Allow patient three tries, then go to next item. • The following word lists have been validated in a clinical stud Version 1 • Banana • Sunrise • Chair Version 2 • Daughter • Heaven • Mountain Version 3 • Village • Kitchen • Baby Version 4 • River • Nation • Finger Version 5 • Captain • Garden • Picture Version 6 • Leader • Season • Table
2. Ask patient to draw the face of a clock. After numbers are on the face, ask patient to draw hands to read 10 minutes after 11:00 (or 20 minutes after 8:00).	Either a blank piece of paper or a preprinted circle (other side) may be used. • A correct response is all numbers placed in approximately the correct positions AND the hands pointing to the 11 and 2 (or the 4 and 8). • These two specific times are more sensitive than others. • A clock should not be visible to the patient during this task. • Refusal to draw a clock is scored abnormal. • Move to next step if clock not complete within three minutes
3. Ask the patient to recall the three words from Step 1.	Ask the patient to recall the three words you stated in Step 1.

Scoring

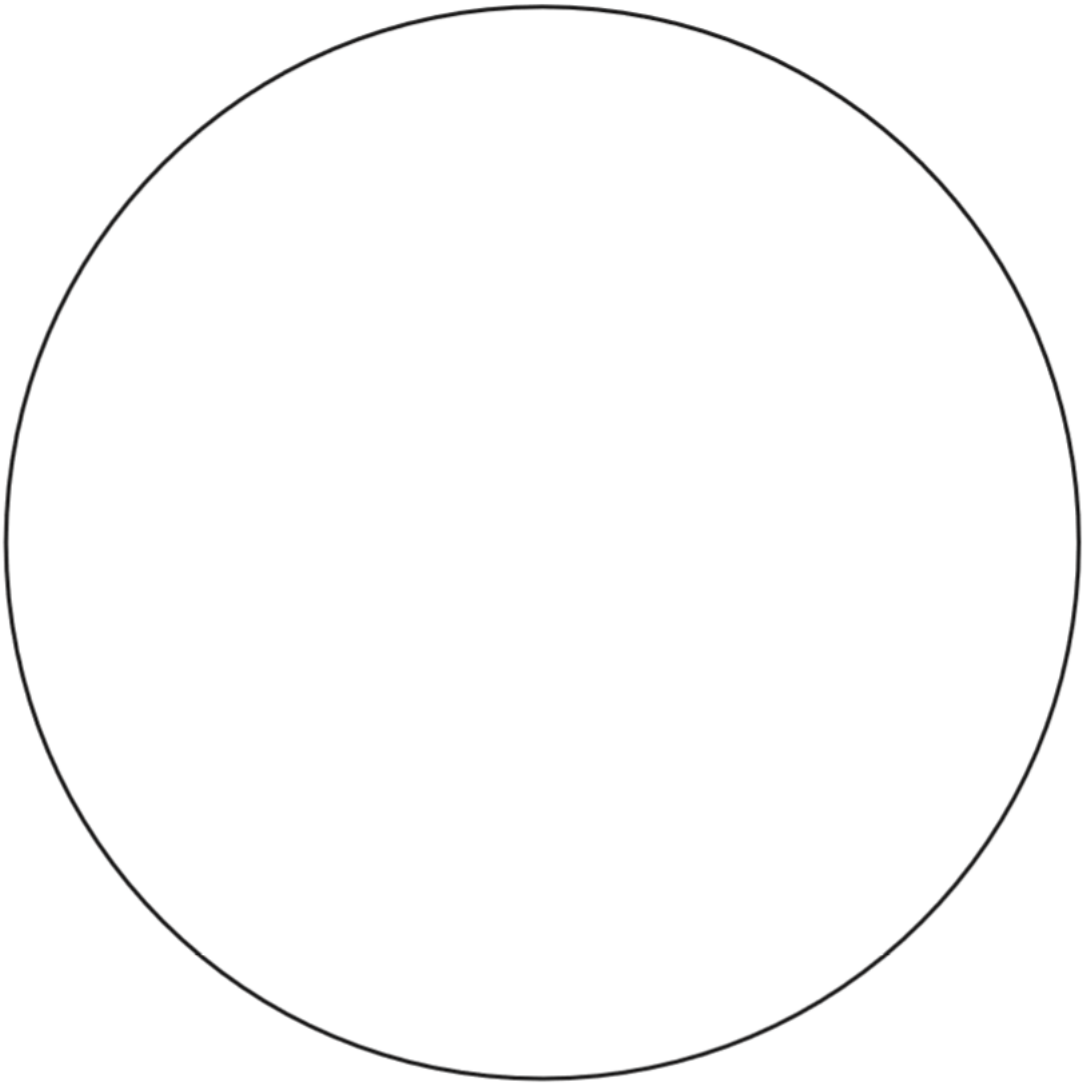
3 recalled words	Negative for cognitive impairment
1-2 recalled words + normal CDT	Negative for cognitive impairment
1-2 recalled words + abnormal CDT	Positive for cognitive impairment
0 recalled words	Positive for cognitive impairment

References

1. Borson S, Scanlan J, Brush M, Vitaliano P, Dokmak A. The mini-cog: a cognitive "vital signs" measure for dementia screening in multi-lingual elderly. Int J Geriatr Psychiatry. 2000;15(11):1021-1027.
2. Borson S, Scanlan JM, Chen P, Ganguli M. The Mini-Cog as a screen for dementia: validation in a population-based sample. J Am Geriatr Soc. 2003;51(10):1451-1454.
3. McCarten JR, Anderson P Kuskowski MA et al. Finding dementia in primary care: the results of a clinical demonstration project. J Am Geritr Soc. 2012;60(2):210-217.

CLOCK DRAWING TEST

Patient Name: _____ **Date:** _____



11.11 TIMED GET UP AND GO TEST

Timed Get Up and Go Test

Instructions:

The person may wear their usual footwear and can use any assistive device they normally use.

1. Have the person sit in the chair with their back to the chair and their arms resting on the arm rests.
2. Ask the person to stand up from a standard chair and walk a distance of 10 ft. (3m).
3. Have the person turn around, walk back to the chair and sit down again.

Timing begins when the person starts to rise from the chair and ends when he or she returns to the chair and sits down.

The person should be given 1 practice trial and then 3actual trial. The times from the three actual trials are averaged.

Predictive Results

Seconds	**Rating**
<10	Freely mobile
<20	Mostly independent
20-29	Variable mobility
>20	Impaired mobility

Source: Podsiadlo, D., Richardson, S. The timed 'Up and Go' Test: a Test of Basic Functional Mobility for Frail Elderly Persons. *Journal of American Geriatric Society*. 1991; 39:142-148

11.12 BARTHEL INDEX

BARTHEL INDEX

Bowels
0 = incontinent (or needs to be given enemata)
1 = occasional accident (once/week)
2 = continent
Patient's Score: _____

Bladder
0 = incontinent, or catheterized and unable to manage
1 = occasional accident (max. once per 24 hours)
2 = continent (for over 7 days)
Patient's Score: _____

Grooming
0 = needs help with personal care
1 = independent face/hair/teeth/shaving (implements provided)
Patient's Score: _____

Toilet use
0 = dependent
1 = needs some help, but can do something alone
2 = independent (on and off, dressing, wiping)
Patient's Score: _____

Feeding
0 = unable
1 = needs help cutting, spreading butter, etc.
2 = independent (food provided within reach)
Patient's Score: _____

Transfer
0 = unable – no sitting balance
1 = major help (one or two people, physical), can sit
2 = minor help (verbal or physical)
3 = independent
Patient's Score: _____

Mobility
0 = immobile
1 = wheelchair independent, including corners, etc.
2 = walks with help of one person (verbal or physical)
3 = independent (but may use any aid, e.g., stick)
Patient's Score: _____

Dressing
0 = dependent
1 = needs help, but can do about half unaided
2 = independent (including buttons, zips, laces, etc.)
Patient's Score: _____

Stairs
0 = unable
1 = needs help (verbal, physical, carrying aid)
2 = independent up and down
Patient's Score: _____

Bathing
0 = dependent
1 = independent (or in shower)
Patient's Score: _____

Total Score: _____

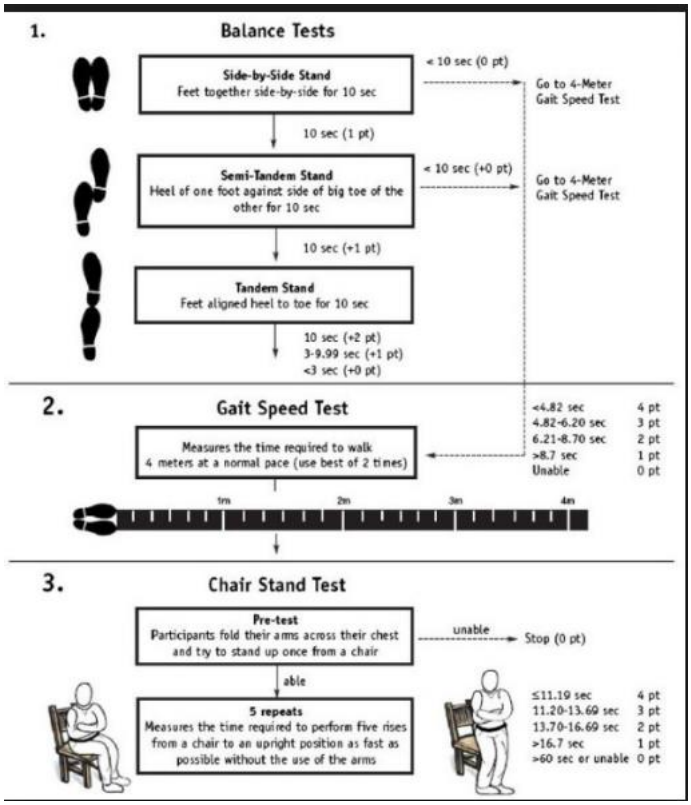
11.13 PHQ2 QUESTIONNAIRE

The Patient Health Questionnaire-2 (PHQ-2)

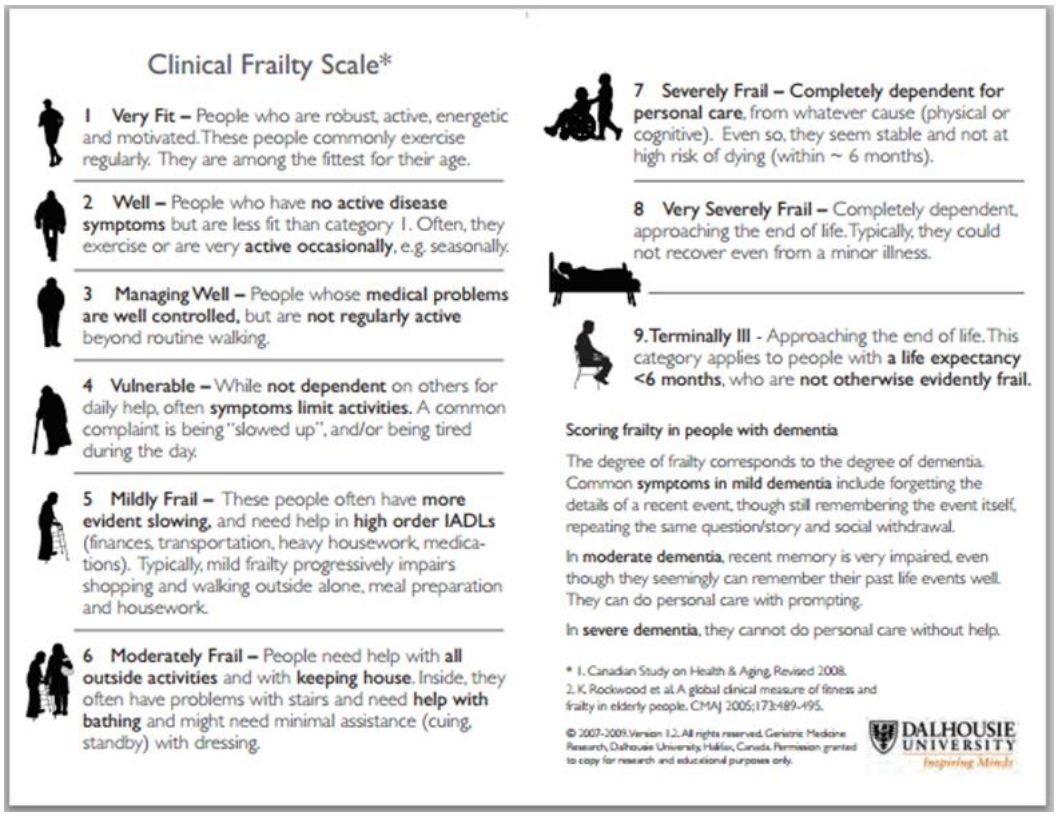
Patient Name _____ Date of Visit _____

Over the past 2 weeks, how often have you been bothered by any of the following problems?	Not At all	Several Days	More Than Half the Days	Nearly Every Day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed or hopeless	0	1	2	3

11.14 SPPB



11.15 CLINICAL FRAILTY SCALE



Clinical Frailty Scale*

1 **Very Fit –** People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2 **Well –** People who have **no active disease symptoms** but are less fit than category 1. Often, they exercise or are very **active occasionally**, e.g. seasonally.

3 **Managing Well –** People whose **medical problems are well controlled,** but are **not regularly active** beyond routine walking.

4 **Vulnerable –** While **not dependent** on others for daily help, often **symptoms limit activities.** A common complaint is being "slowed up", and/or being tired during the day.

5 **Mildly Frail –** These people often have **more evident slowing,** and need help in **high order IADLs** (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6 **Moderately Frail –** People need help with **all outside activities** and with **keeping house.** Inside, they often have problems with stairs and need **help with bathing** and might need minimal assistance (cuing, standby) with dressing.

7 **Severely Frail – Completely dependent for personal care,** from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8 **Very Severely Frail –** Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9. **Terminally Ill** - Approaching the end of life. This category applies to people with **a life expectancy <6 months,** who are **not otherwise evidently frail.**

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common **symptoms in mild dementia** include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/story and social withdrawal.

In **moderate dementia,** recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In **severe dementia,** they cannot do personal care without help.

* 1. Canadian Study on Health & Aging, Revised 2008.
2. K. Rockwood et al. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005;173:489-495.

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11.16 PRISMA QUESTIONS

Box 1

Prisma 7 Questions

1] Are you more than 85 years?
2] Male?
3] In general do you have any health problems that require you to limit your activities?
4] Do you need someone to help you on a regular basis?
5] In general do you have any health problems that require you to stay at home?
6] In case of need can you count on someone close to you?
7] Do you regularly use a stick, walker or wheelchair to get about?

11.17 EDMONTON FRAIL SCALE

The Edmonton Frail Scale

NAME : _____

d.o.b. : _____ **DATE :** _____

Frailty domain	Item	0 point	1 point	2 points
Cognition	Please imagine that this pre-drawn circle is a clock. I would like you to place the numbers in the correct positions then place the hands to indicate a time of 'ten after eleven'	No errors	Minor spacing errors	Other errors
General health status	In the past year, how many times have you been admitted to a hospital?	0	1–2	≥2
	In general, how would you describe your health?	'Excellent', 'Very good', 'Good'	'Fair'	'Poor'
Functional independence	With how many of the following activities do you require help? (meal preparation, shopping, transportation, telephone, housekeeping, laundry, managing money, taking medications)	0–1	2–4	5–8
Social support	When you need help, can you count on someone who is willing and able to meet your needs?	Always	Sometimes	Never
Medication use	Do you use five or more different prescription medications on a regular basis?	No	Yes	
	At times, do you forget to take your prescription medications?	No	Yes	
Nutrition	Have you recently lost weight such that your clothing has become looser?	No	Yes	
Mood	Do you often feel sad or depressed?	No	Yes	
Continence	Do you have a problem with losing control of urine when you don't want to?	No	Yes	
Functional performance	I would like you to sit in this chair with your back and arms resting. Then, when I say 'GO', please stand up and walk at a safe and comfortable pace to the mark on the floor (approximately 3 m away), return to the chair and sit down'	0–10 s	11–20 s	One of : >20 s , or patient unwilling , or requires assistance
Totals	Final score is the sum of column totals			

Scoring :
0 - 5 = Not Frail
6 - 7 = Vulnerable
8 - 9 = Mild Frailty
10-11 = Moderate Frailty
12-17 = Severe Frailty

TOTAL /17

Administered by : _____

11.18 FRIEDS FRAILTY PHENOTYPE

The frailty phenotype is defined as meeting three or more of the following five criteria. Prefrailty is defined as one or two of these characteristics, and not frail as having none.

- Weight loss (≥5 percent of body weight in last year)
- Exhaustion (positive response to questions regarding effort required for activity)

●Weakness (decreased grip strength)

●Slow walking speed (gait speed) (>6 to 7 seconds to walk 15 feet)

●Decreased physical activity (Kcals spent per week: males expending <383 Kcals and females <270 Kcal)

11.19 DATA SHEET

PROFORMA

NAME CONTACT NO 1)

2)

DEMOGRAPHY

---

1) HOSPITAL NO.
2) AGE
3) SEX 1]MALE
   2]FEMALE
4) SOCIOECONOMIC STATUS(Kuppuswamy scale)
   1)UPPER
   2)UPPER MIDDLE
   3)LOWER MIDDLE
   3)UPPER LOWER
   4)LOWER

5) COMORBIDITIES
   1)HYPERTENSION Y (1) N(2) YEARS
   2)DIABETES MELITUS Y (1) N(2) YEARS
   3)ISCHEMIC HEART DISEASE Y (1) N(2) YEARS
   4)CEREBROVASCULAR ACCIDENT Y (1) N(2) YEARS
   5)DYSLIPIDEMIA Y (1) N(2) YEARS
   6)COPD Y (1) N(2) YEARS

6]CHARLSON COMORBIDITY SCORE

1)LOW – 0

2)MEDIUM – 1-2

3)HIGH – 3-4

4)VERY HIGH >5

7)Mini Nutritional Assessment

Last name: First name: Sex: Date:

Age: Weight, kg: Height, cm: I.D. Number:

Complete the screen by filling in the boxes with the appropriate numbers.
Add the numbers for the screen. If score is 11 or less, continue with the assessment to gain a Malnutrition Indicator Score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe loss of appetite
1 = moderate loss of appetite
2 = no loss of appetite ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed/chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F Body Mass Index (BMI) (weight in kg) / (height in m)²
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

Screening score (subtotal max. 14 points) ☐☐
12 points or greater Normal – not at risk – no need to complete assessment
11 points or below Possible malnutrition – continue assessment

Assessment

G Lives independently (not in a nursing home or hospital)
0 = no 1 = yes ☐

H Takes more than 3 prescription drugs per day
0 = yes 1 = no ☐

I Pressure sores or skin ulcers
0 = yes 1 = no ☐

J How many full meals does the patient eat daily?
0 = 1 meal
1 = 2 meals
2 = 3 meals ☐

K Selected consumption markers for protein intake
- At least one serving of dairy products (milk, cheese, yogurt) per day? yes ☐ no ☐
- Two or more servings of legumes or eggs per week? yes ☐ no ☐
- Meat, fish or poultry every day yes ☐ no ☐

0.0 = if 0 or 1 yes
0.5 = if 2 yes
1.0 = if 3 yes ☐.☐

L Consumes two or more servings of fruits or vegetables per day?
0 = no 1 = yes ☐

M How much fluid (water, juice, coffee, tea, milk…) is consumed per day?
0.0 = less than 3 cups
0.5 = 3 to 5 cups
1.0 = more than 5 cups ☐.☐

N Mode of feeding
0 = unable to eat without assistance
1 = self-fed with some difficulty
2 = self-fed without any problem ☐

O Self view of nutritional status
0 = views self as being malnourished
1 = is uncertain of nutritional state
2 = views self as having no nutritional problem ☐

P In comparison with other people of the same age, how does the patient consider his/her health status?
0.0 = not as good
0.5 = does not know
1.0 = as good
2.0 = better ☐.☐

Q Mid-arm circumference (MAC) in cm
0.0 = MAC less than 21
0.5 = MAC 21 to 22
1.0 = MAC 22 or greater ☐.☐

R Calf circumference (CC) in cm
0 = CC less than 31 1 = CC 31 or greater ☐

Assessment (max. 16 points) ☐☐.☐
Screening score ☐☐
Total Assessment (max. 30 points) ☐☐.☐

Malnutrition Indicator Score
17 to 23.5 points at risk of malnutrition ☐
Less than 17 points malnourished ☐

Ref.: Guigoz Y, Vellas B and Garry P.J. 1994. Mini Nutritional Assessment: A practical assessment tool for grading the nutritional state of elderly patients. *Facts and Research in Gerontology.* Supplement #2:15-59.
Rubenstein LZ, Harker J, Guigoz Y and Vellas B. Comprehensive Geriatric Assessment (CGA) and the MNA: An Overview of CGA, Nutritional Assessment, and Development of a Shortened Version of the MNA. In: "Mini Nutritional Assessment (MNA): Research and Practice in the Elderly". Vellas B, Garry P.J and Guigoz Y., editors. Nestlé Nutrition Workshop Series. Clinical & Performance Programme, vol. 1. Karger, Bâle, in press.

8] MEDICATIONS

ACE INHIBITORS Y(1) N(2)

BETABLOCKERS Y(1) N(2)

CALCIUM CHANNEL BLOCKERS Y(1) N(2)

DIURETICS Y(1) N(2)

BENZODIAZEPINES Y(1) N(2)

ANTIDEPRESSANTS Y(1) N(2)

Total number of medications -____

GERIATRIC ASSESSMENT

9] Mini COG test

10]ADL score

Barthel Index -

11]HAND GRIP

Score - RIGHT LEFT -

12]TIMED GET UP AND GO -

13]GAIT SPEED -

14] FRAILTY ASSESSMENT

Fried or Hopkins Frailty Phenotype

a. Weight loss (≥5 percent of body weight in last year)
b. Exhaustion (positive response to questions regarding effort required for activity)
c. Weakness (decreased grip strength)
d. Slow walking speed (gait speed) (>6 to 7 seconds to walk 15 feet)
e. Decreased physical activity (Kcals spent per week: males expending <383 Kcals and females <270 Kcal)

- Frailty - 3 or more of five
- Prefrailty - 1 or 2
- Not frail - none.

15] Serum ALBUMIN

16] Hemoglobin

17]Mean corpuscular Volume

18] DEPRESSION SCREEN – PHQ 2 SCORE -

11.20 INFORMATION SHEET

NUTRITIONAL STATUS OF ELDERLY PRESENTING TO GERIATRICS OUT-PATIENT CLINIC USING MINI NUTRITIONAL ASSESSMENT AND CORRELATION WITH FRAILTY AND FUNCTIONAL STATUS

Patient information sheet:

The Mini Nutritional Assessment [MNA] is a validated nutrition screening and assessment tool that can identify geriatric patients age 65 and above who are malnourished or at risk of malnutrition. The MNA was developed nearly 20 years ago and is the most well validated nutrition screening tool for the elderly. MNA consists of 18 questions and streamlines the screening process. The current MNA retains the validity and accuracy of the original MNA in identifying older adults who are malnourished or at risk of malnutrition.

Frailty is often defined as a syndrome characterized by loss of biologic reserves resulting in increased vulnerability to minor stressors and risk for adverse outcomes, including disability, hospitalization, and death.

We are trying to study if the nutritional status of a person is related to frailty.

What will I have to do to take part in the part?

i. Sign the consent form
ii. Give personal details
iii. Give a detailed nutritional history
iv. Give consent for examination including height, weight, mid-arm circumference, hand grip strength and walking speed.

Is there any risk?

The patient will not have any risk in participating in the study.

Will I have to pay for investigations?

Patients will not be charged for this study.

What advantage will I get from this study?

a) By participating in this study, the patient's nutritional status is assessed and is advised regarding proper nutrition.

Will my personal details be kept confidential?

We aim to publish the results of this study in a medical journal, but you will not be identified by name in any publication or presentation of results. However, your medical notes may be reviewed by people associated with the study, without your additional permission.

Can I withdraw from this study after it starts?

Participation in this study is entirely voluntary; you can withdraw from the study at any time. Refusal to participate will not involve any loss of benefits to which you are otherwise entitled.

11.21 CONSENT SHEET

Informed Consent form to participate in a research study

Study Title: NUTRITIONAL STATUS OF ELDERLY PRESENTING TO GERIATRICS OUT-PATIENT CLINIC USING MINI NUTRITIONAL ASSESSMENT AND CORRELATION WITH FRAILTY AND FUNCTIONAL STATUS

Study Number: _____

Subject's Initials: _____

Subject's Name: _____

Date of Birth / Age: _____

(Subject)

(i) I confirm that I have read and understood the information sheet dated _____ for the above study and have had the opportunity to ask questions.

(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) I understand that the Sponsor of the clinical trial, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

(iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).

(v) I agree to take part in the above study.

Signature of the Subject/Legally Acceptable Thumb impression of the Subject

Date: _____/_____/_____

Signatory's Name: _____

Signature of the Investigator: _____

Date: _____/_____/_____

Study Investigator's Name: ----------

Signature of the Witness: _____ Thumb impression

Date: _____/_____/_____

Name & Address of the Witness: _____

11.22 ALL DATA